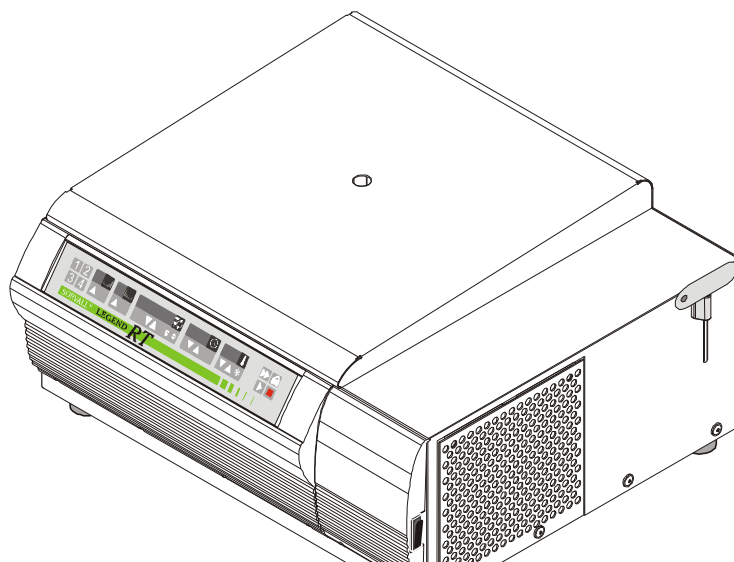
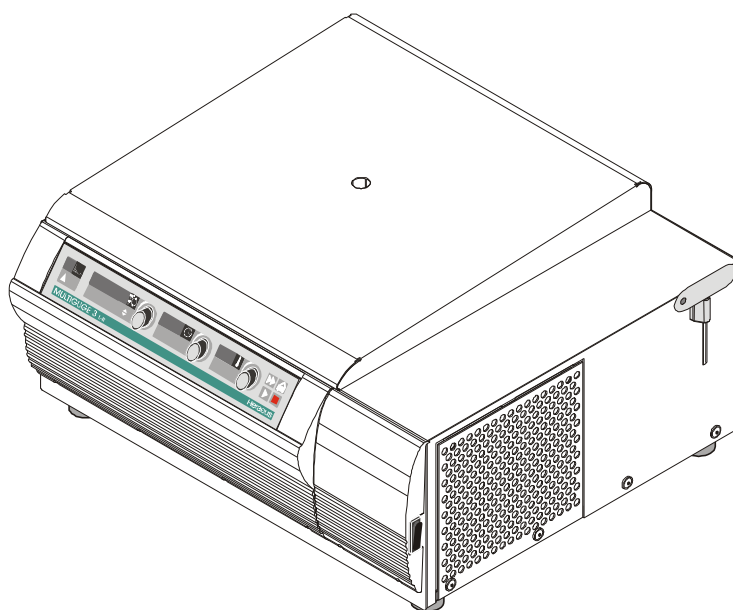


# Multifuge<sup>®</sup> 3 S-R/3 L-R, Legend<sup>®</sup> RT 120V 50/60 Hz SERVICE MANUAL

P/N 12004376



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## Service

### 2.1 Servicing Schedule (yearly procedure recommended)

#### 2.1.1 Maintenance Routine without Dismantling the Centrifuge

##### 2.1.1.1 Electrical Installation and Safety

- Switch OFF the centrifuge and disconnect the unit from power, check voltage supply and mains fusing (16 Amps, slow blow characteristic)
- Check condition of plug and wall socket - replace defective parts (customer's responsibility)
- Check cord condition and fixing / connection - replace or refit it
- Check condition of instrument socket and replace it in case of bad contacts

##### 2.1.1.2 Location and Mechanical Installation

- Check the base (ground, table, lorry with lockable wheels etc.) for resonance-free and stable conditions
- Check for a well ventilated place and sufficient distances to walls or adjacent equipment, without exposition to direct sunlight
- Check the leveling of the centrifuge drive with use of a spirit level

##### 2.1.1.3 Lid Tumbler Mechanism and Safety Device

- Connect the centrifuge to power and switch ON
- Check for correct automatic lid closing and self-acting lid opening - if in disorder, readjust lid, swivel hinges, and/or locking devices
- Check the rubber gasket for lid's and bolt's sealing and replace, if damaged
- For checking the electronically safety circuit: start the centrifuge, let it shortly run and stop it, the lid must not be unlocked by the microprocessor as long as the speed is more than 60 rpm - if safety circuit is out of function, replace main board

##### 2.1.1.4 Cleanliness of Spin Chamber and Motor Casing

- Open the lid and remove the rotor (for loosening turn the T-handle Allen key (5mm) in arrow direction - see rim of rotor chamber)
- Clean the spin chamber with a dry and absorbent cloth (remove all dust and moisture - see also section for Cleaning)
- Check the cleanliness of the motor flange and take care of the annular slot around the motor shaft: penetrating fluids can damage the upper spindle bearing or electronics, remove fluids with an injector and/or absorbent paper

##### 2.1.1.5 Rotor and Accessories Condition and Sealing, bellows

- Check the condition of rotors and accessory parts (especially all supporting or stressed partitions): the rotor and/or accessory parts must not be used any longer, if there are visible traces of mechanical damage or rust
- Check the condition of rotor and/or accessory sealing and replace them in case of malfunction
- Bellows of gas lid stays have to be greased upside down with glycerin (part no. 70902649) once a year.

##### 2.1.1.6 Rotor Fixing and Drive Spindle

- Check the perfect condition of the collet chuck and replace it in case of malfunction (thread is worn out, horizontal grooves etc.)
- Check the condition of the drive cone: the centrifuge must not be used any longer, if the drive cone is damaged (e.g. bend or it's bearings are worn out)

#### 2.1.1.7 *Temperature Level (not at every unit)*

- Check the wire gauze (behind the air inlet slots) left and right side for free ventilation, insufficient air flow will lead to an inadmissible temperature rise of compressor, motor and electronic parts

#### 2.1.1.8 *Imbalance Behavior*

- Install available and empty rotors and check the imbalance behaviour with rotor dependant cut off and run through weights (see 2.5) and replace worn out motor rubber mounts, faulty main board or sensor board

### 2.1.2 Maintenance Routine after Dismantling the Centrifuge Casing

#### 2.1.2.1 *Motor Supporting Elements*

- Check the supporting and damping elements of the drive motor and replace them in case of increased rubber abrasion or abundance of imbalance but at least every 3 years

#### 2.1.2.2 *Braking Circuit*

- Check the function of the braking circuit (warming up of brake resistor, even and noiseless brake effect) and replace defective parts in case of malfunction

#### 2.1.2.3 *Lead and Screwing Connections*

- Check the terminal and plug connections of all leads and on all boards and electrical components, tighten all loosen screwing connections, refit or replace defective parts
- Check the wedged connections of the board, mechanical and electrical components and re-tighten them if necessary (use screw locking lacquer for motor mounts and lid lock assembly)

#### 2.1.2.4 *Protection Earth Core and Grounding Connections*

- Check the protection earth core for continuity and all grounding plug connectors (see also 2.7 Electrical Safety Check)
- Check isolation resistance and accessible current (see 2.7)

## 2.2 Trouble Shooting

Error Indication	Error Cause	Possible Error Source	Corrective Procedure
Displays remain dark	No mains voltage supply	Mains switch with integrated fuse or fuses on main board	Switch on again, disconnect electric. components success., search for other faults
		Mains fuse or circuit breaker failed	Check fuse or circuit breaker and replace or switch on again
		Faulty mains cord or instrument socket	Check instrument cord and socket, replace defective parts
	No low voltage supply for indication board	Faulty connection from CPU to indication board	Check connections on CPU, indication board and connecting leads, replace defective parts
		Faulty indication or CPU board	Replace main board completely
	Interrupted program	NV-RAM out of socket or not correctly placed	Insert the valid NV-RAM and push it correctly into socket
All display Elements are shortly illuminated	CPU program reset may be caused by EMI	Reduced voltage supply (<10%)	Remedy the failure if the voltage drops often, use a voltage stabilizer
		Bad or missing ground connection	Check all ground connections and the ground connection of all boards
Constant	Interruption	Parameter NV-RAM	No or defective NV-RAM
Drive makes noises -no good separation result	Mechanics	wear out of motor rubber mount	Replace motor rubber mounts (at least every three years)
	Electrical	Defective terminal connection, faulty lead or motor winding	Check voltage on motor terminal and winding resistances -see test points on main board
		Faulty power electr.	Replace main board
Lid cannot be opened by key at standstill	Locking drive is not supplied with voltage	24V supply faulty relay K2 faulty driving circuit	Check voltage for drive motor Check switch. after power ON Replace the main board No or defective NV-RAM
	Latch motor	Faulty motor winding	Replace complete motor
	Lid is not correctly locked	Lid bolt is jamming	Push lid centrally into lock and press the key again
		Lid is deformed	Re-adjust the lid centrally

## 2.3 Error code

Error Indication	Error Cause	Possible Error Source	Corrective Procedure
„rotor“ in speed display	Wrong selection of detected rotor	Inadmissible speed or rcf value was pre-selected	Press start again (within 15s), else wait for rotor standstill, lid OPEN/CLOSE, set value, start
“bAL” message appears in speed display	Imbalance run	Rotor not symmetrically loaded	Open lid, check rotor loading, close lid again and restart
		Base is not sturdy enough and comes into vibrations	Change or reinforce the base (table, lorry with lockable wheels, etc.)
		Centrifuge drive is not correctly leveled	Level the drive correctly by means of unit's feet
		Rotor itself has imbalance	Rotor must no longer be used, send back to Kendro
		Drive shaft or rotor fixing is damaged	Replace collet chuck or motor
		Imbalance sensor	Replace sensor board
		Circuits of main board	Replace the main board
“Lid” appears in speed display	Lid was opened manually during run	Forbidden intervention emergency opening device must only be used at standstill	Close lid immediately, turn power OFF/ON, press lid down for locking, press start key, press stop to finish run
	Protection circuit (20V) interrupted during run	Defective micro switch or leads or connectors to micro switch are interrupted	Check leads and connectors to micro switch, in case of a faulty micro switch, replace them
„OPEn“ appears in speed display by supposedly closed lid	20V supply for protection circuit is interrupted at standstill	Loose plug connectors	Check plug X20
		Interrupted leads to micro switch	Check leads to micro switch for continuity
		Defective micro switch	Replace micro switch
“S-LID” appears in display	Sensor signal not clear	Latch not in valid position during power on	Switch unit “off” and “on” again

**Error Code**

Error Indication	Error Cause	Possible Error Source	Corrective Procedure
„E-01“ message	System clock pulse not stable	Hardware fault on main board	Change main board
„E-02“ message	program sequence was disturbed	Internal Software problem	Change CPU, replace main board
„E-03“ message	Stack overflow	Internal Software problem	No action in the field possible
„E-04“ message	Stack underflow	Internal Software problem	No action in the field possible
“E-05” message	Reset by HW watchdog timer	Software problem	No action in the field possible
“E-06” message	Data lines to key board disturbed	Wiring display board	Check wiring and connectors
“E-07” message	Display board doesn't match to main board cooled/non-cooled	Check software	Replace NV RAM and CPU
“E-08” message	Check sum error E-PROM	E-PROM failed	Replace E-PROM
“E-09” message	Check sum error NV RAM	NV RAM failed	Replace NV RAM
“E-10” message	NV RAM not initialized	Initializing of NV-RAM is not valid	check NV-RAM and socket, insert the correct NV-RAM
“E-11” message	NV RAM doesn't match E-PROM	Check versions of NV RAM and E-PROM	Replace NV RAM and E-PROM
“E-12” message	Check sum error NV RAM	NV RAM failed	Replace NV RAM
“E-13” message	Check sum error NV RAM	NV RAM failed	Replace NV RAM
„E-14“ message	chamber over temperature: display >50°C	Compressor didn't work	Check leads, terminals, start relay, capacitor, compressor
		Faulty cooling cycle	Exp. valve, refrigerant loss
„E-15“ message	Open temp. sensor	Check sensor, control circuits	Replace sensor or main board
„E-16“ message	Short cut temp. sensor	Check sensor, control circuits	Replace sensor or main board
„E-17“ message	wrong or faulty rotor detection	a wrong rotor was installed	wait for standstill, open the lid and install a correct rotor
		Mains voltage failure	press stop key, wait for standstill and restart
		Faulty detection circuit	replace the main board

**Error Code**

Error Indication	Error Cause	Possible Error Source	Corrective Procedure
„E-18“ message	Bucket code not valid for this rotor	Not valid	
„E-19“ message	Rotor code not programmed	Wrong rotor installed	Check rotor
		Interference during recognition	Check rotor recognition board and wiring
„E-20“ message	rotor code not valid	See E-19	
„E-21“ message	Recognition disturbance	wiring	Check wiring
„E-22“ message	Speed signal disturbance	wiring	Check wiring
„E-23“ message	Speed control measuring disturbance	2 <sup>nd</sup> check was done by rotor recognition system	Check speed detection board
„E-24“ message	Latch not in top position	Micro switch failed, de-adjusted, latch	Check micro switch adjustment, if necessary replace it
„E-25“ message	Time out latch open	Hall sensor signal not applied	Check latch motor and PCB
„E-26“ message	Time out latch close	Hall sensor signal not applied	Check latch motor and PCB
„E-27“ message	Signal given by latch not valid	Wrong identified signal after power “on”	Check hall sensors
„E-28“ message	Wrong sense of rotation	After replacement of the motor- wires mixed	Check wiring at terminal
„E-29“ message	Motor doesn't turn	PCB faulty, see E-21, E-22	Change PCB, rotor recognition, speed detection, fasten motor wiring at terminal
„E-30“ message	Control-voltage interruption	PCB failed	Replace PCB
„E-31“ message	over-temperature motor >150°C	Hot motor, no air circulation	Check motor, check grill for dust
„E-32“ message	Over-temperature Electronic	Faulty main board	Replace main board
„E-33“ message	High-pressure Cooling system	Faulty high pressure switch, blocked system	Inspect cooling system



**Error Code**

<b>Error Indication</b>	<b>Error Cause</b>	<b>Possible Error Source</b>	<b>Corrective Procedure</b>
„E-34“ message	Over-voltage	Brake resistor, main board	Check brake resistors, replace main board
„E-35“ message	Over-current	Main board	Replace main board
„E-36“ message	NMI interruption	Over voltage or over-current	Replace main board
„E-37“ message	Over-current continuously	Main board	Replace main board
„E-38“ message	Current measurement disturbed	Analog signal > hardware over current	Replace main board
„E-39“ message	Speed control check >n max.	Speed > calculated speed	Check speed detection board, replace the main board
„E-40“ message	Acceleration of the unit is too slow	Big imbalance Motor or main board faulty	Check rotor loading, motor and main board
„E-41“ message	Offset voltage from the imbalance sensor is in a inadmissible area	Imbalance sensor faulty Wiring from the speed detection board to the main board is broken	Replace speed detection board Check / replace the wiring

## 2.4 Test Points

Test Points	Unit Value	Conditions
Mains terminal Board resistance	120V 50Ω	All given values are related on 120 V (+/- 10%) mains voltage for board supply
Motor over-temp. terminal <b>X20/B3,B4*</b>	20V DC	Voltage drop by one disconnected lead (error case) and linked terminal XR
Over-press switch terminal <b>X20/P</b>	20V DC	Voltage drop by one disconnected lead (error case) and linked terminal XO
Fans cooling plant terminal <b>XK</b>	100 Ω 82 Ω	Switch OFF unit, fan resistance temperature 20°C wire black to blue wire brown to blue
Compressor terminal <b>XG</b> terminal box –insulation value	6,5 A 1,6 Ω 4,8 Ω > 10MΩ	Switch OFF unit, compressor temp. 20°C Resistance of main coil + (starting relay 0.1Ω) Resistance of auxiliary coil (joints 13 -> 14) Resistance inter phase and motor casing
Speed detection plug XW (1 to 4) (3 to 4)  speed	5V DC 4,4V 0V n=f*30	Board with active filter circuit Low voltage supply Light barrier is passed through (slot position) Light barrier is out (turn cone a little by hand) When centrifuge is running
Imbalance sensor plug <b>XW</b> (1→4) (2→4)	12V DC a(t)	Low voltage supply of sensor board Amplitude of lateral acceleration is rotor and speed dependent, analyzed for n > 250 rpm
Motor current $I_M$ cable ( <b>U,V,W</b> )	3 * 7A	Split core transformer with Flukemeter maximum during acceleration
	3 * 5,2A 3 * 3,0A	Rotor #6441, set speed = 3750min <sup>-1</sup> , 560W
Motor winding resistance 20°C – insulation value	3x2,5Ω > 10MΩ	Switch OFF unit, pull off motor plugs, measure inter U -> V, V -> W, W -> U Resistance inter each phase and motor casing
Brake resistor terminal <b>XD</b>	60Ω	Switch OFF unit, 2 resistors parallel connected, resistance at 20°C
Rotor detection plug <b>XR</b>	5V DC 0V DC	Per rotor revolution 2 different long pulses are separated from 2 different pulse pause lengths, this pulse mode is generated by 4 alternately polarized magnets
Temp. measuring plug <b>XU</b>		Chamber temperature 20°C (PT100: ≈ 108Ω) Chamber temperature -10°C (PT100: ≈ 96Ω) Chamber temperature 40°C (PT100: ≈ 116Ω)

## 2.5 Imbalance Behaviour

- **Install** in table available **rotor(s)** in unloaded condition

Rotor/Bucket	Run through weight	Cut off weight
75006445/75006441	20 grams	30 – 40 grams

- Insert rotor dependent **cut-off weights** and position them at angles of 90° to each other, the centrifuge must stop 4 times indicating “bAL” message - in case of false behaviour see trouble shooting: no “bAL” indication.
- Insert the **admissible imbalance weights** in the same manner, the centrifuge must run through 4 times to maximum rotor speed.

## 2.6 Cleaning of Instrument Parts

### ATTENTION - WARNING!

**The electrical and electronic components must not be cleaned with moist detergents!**

For Cleaning the centrifuge housing or its accessories see Operating Instructions section 1 (maintenance and care).

- **Electronic components**  
Clean dusty components carefully with a dry and soft brush and remove loose dust with a vacuum cleaner.
- **Fans**  
Scratch off carefully with a knife or similar tool the crusted dirt from the fans' blades. Resulting grooves or marks must be removed subsequently with a fine abrasive cloth. Loose dirt is to remove with an absorbent cloth or vacuum cleaner.
- **Vent holes**  
Remove dirt from the vent grid behind the front panel by using a brush and vacuum cleaner.
- **Condensers of cooling plant (if available)**  
The louvers between the condensers' heat air deflectors have to be vacuum cleaned. In case of persistent dirt the unit must be carried to an appropriate place where the condensers can be cleaned with compressed air from inside to outside. Bended heat air deflectors have to be realigned correctly.

## 2.7 Electrical Safety Check

### ATTENTION!

A final electrical safety check must be performed after each maintenance and/or repair!

- **Resistance check of protective conductor**

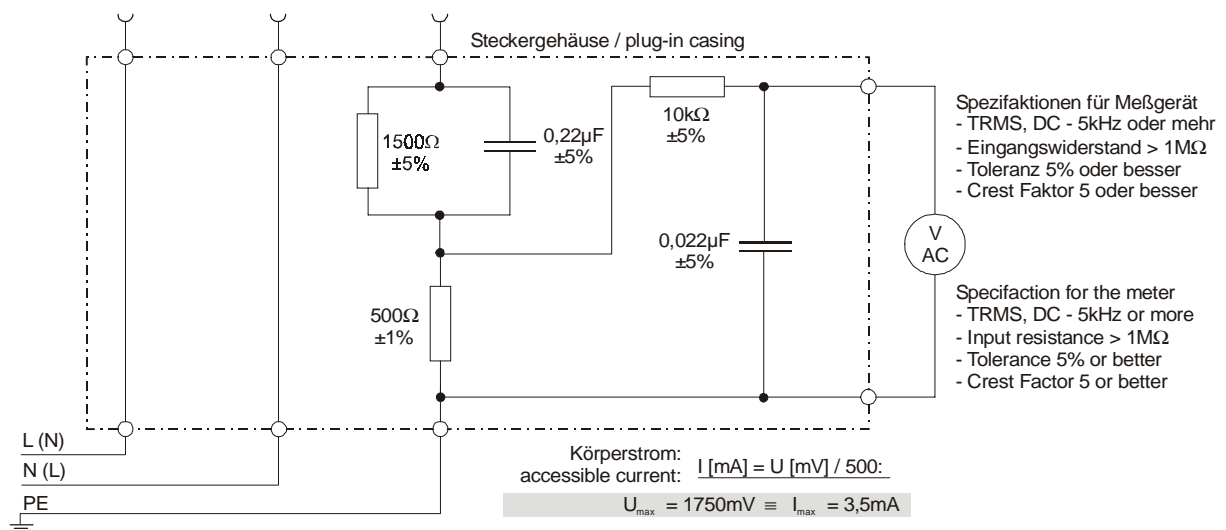
The measuring value of the resistance between the mains plug's grounding pin and the grounding conductors of the motor, electronic chassis and the casing must not exceed 200 mΩ.

- **Insulation resistance Check**

Check also the insulation resistance between the poles of the mains plug and the grounding conductor; the resistance value must be more than 2 MΩ.

- **Accessible current measured to EN 61 010**

The accessible current must not exceed 3.5 mAmps in single fault condition (interrupted protection earth wire)! In accordance with the EN61010, IEC1010 and UL3101 such a fault condition can be reproduced by the following measuring circuit.



### 3 Functional Description

#### 3.1 Block Functions

The Multifuge 3L-R/3S-R, Legend RT is a refrigerated microprocessor controlled laboratory tabletop centrifuge with noise reduced induction drive motor incorporating automatic rotor and imbalance detection and self-closing door locking systems.

The unit is equipped with following boards and components (block diagram 4-1):

- Instrument socket for mains cable at the back
- Two poles mains switch
- Main board with microprocessor part and power electronics
- Key and indication board (program: EASYCONTROL II with temp. Display or QUICK-CONTROL with adjusting knob)
- Sensor board with rotor detection sensors
- 3 phase induction motor with integrated thermal over-temperature switch (C. O. 150°C)
- Speed detection and imbalance board with filter attached to the motor's bottom by screws
- self-closing door locking system (mechanical bolt keeper, motor dis-locking)
- 2 parallel brake resistors mounted on safety chamber (one with overtemp.sensor)
- axial-flow fan for power electronics, motor and chamber

#### 3.2 Main Board Functions

The **Main board** is mounted at the housing behind the front panel. The components on main board are arranged in following function blocks (see wiring diagram page 4-2 and 4-3).

- Noise filter in accordance with EN 55011 for motor and triac circuits
- Power pack for low voltage supply of microprocessor part and power electronics
- Triac driving circuits for compressor cut-in relay, for 2 independent fan wiring terminals and for connection of a heater (special use)
- DC intermediate circuit for supply of frequency converter equipped with automatic loading and voltage (brake) controlling circuits
- Power part inclusive physically separated driving stages
- Microprocessor part with CPU, E-PROM and NV RAM
- Driving component for self-closing lid lock device
- Interface component for serial RS232 (option)
- Exchangeable NV-Ram and E-PROM containing specific data of the unit

##### 3.2.1 Power Pack

The power pack consists of 2 transformers, 2 rectifiers (single diode) and 2 voltage regulators, which generates the following low voltage levels:

- U1 = 5V: by switched-mode regulator LM2575T-5.0, VDD, VCC  
supplies all processors and its electronic components on main and indication board
- U2 = 24V: unregulated  
is used for the driving of lid lock motor and relays K2, K3;  
the reference potential is GND, VSS
- U3 = 20V: by 2nd transformer, rectifier diodes and fix voltage regulator 7820  
serves for supply of driving of the power electronics via the protection circuit by closed lid switches  
reference potential: **0V CAUTION - MAINS POTENTIAL!**

## Main Board Functions

### 3.2.2 Intermediate Circuit

The DC intermediate circuit serves as an energy store between the AC power input and the transmitted motor performance. The intermediate circuit consists of a heat-sink-cooled bridge rectifier and several reservoir capacitors which are softly charged across a power resistor R76 when ever the unit is switched on. After the loading time (CPU initialization time) the power resistor is linked by the relay contacts of K3. When switching the unit off, the DC voltage of the intermediate circuit is discharged across a path of resistor R1, R2.

### 3.2.3 Brake Path

Electrical power is fed back into the intermediate circuit during motor deceleration (motor acts as generator). This braking power is transformed into heat by two parallel connected resistors so that the intermediate circuit voltage does not rise to an excessive level. The brake resistors are switched into the intermediate circuit by a fast switching transistor (pulse-width modulation, synchronized by the double mains frequency). This transistor is voltage dependent controlled by a self-acting stage (closed loop).

### 3.2.4 Frequency Converter

The motor is 3-phased, provided with chopped direct voltage blocks (chopped frequency approx. 5kHz, amplitude is height of DC intermediate voltage). These blocks are variable in frequency and pulse-width modulation, 120° out of phase. These 3 phases are controlled during acceleration, running at set speed and deceleration (e.g. for small speed: low frequency and small pulse-width length will be affected). The FC is protected against over current, over temperature and over-voltage.

### 3.2.5 Microcontroller (Central Processing Unit) Part

The software identification No's of the CPU and data storage's (NV-RAM) ST24C32 are sequentially displayed in speed and time fields:

Press program place no 2 during switch on

• <b>CPU Operating panel:</b>	526	P05
• <b>Firmware:</b>	528	200
• <b>NV-RAM:</b>	4468	105

The actually indicated version No.'s are displayed in the time field and will be upgraded if program or data changes are necessary.

The control program (ROM) is integrated in the controller component. The most important operating parameters (e.g. the maximum data for all rotors, the last operator settings, the basic values for speed and temperature controlling, data of acceleration and deceleration curves as well as 4 data sets of program places are stored in the non volatile (NV)-RAM.

When calling this routine the actual value of all centrifugation cycles ("CYL") is also shown in the display (as fourth No.) before the check routine for all program places puts an end to the initialization time (approx. 18s).

The CPU co-operates with the E-PROM component via the 16 bit data bus and some control lines. The CPU is an integrated circuit, generating all required output signals, monitoring and analyzing all input signals.

### 3.3 Key and Indication Board - Easycontrol

The key and indication board is mounted behind the operating panel. The connection to the main board is done by a 4 pole cable by which the serial data transfer as well as the low voltage supply of 5V is verified. The 7-segment displays, the control LED's and the operating keys are managed by an own controller unit (first identification No. 591) in multiplex processing.  
For the programming serves EASYCONTROL II (see Operating Instructions).

#### Functions of keys elements (Easycontrol)

Keys	Designation	Function(s)
S1 – S4	Program place 1 to 4	Store or recall programs
S5	Arrow up	Acceleration profile 1 to 9
S6	Arrow down	Deceleration profile 1 to 9
S7	Speed arrow down	Decrement the value of the set speed
S8	Speed arrow up	Increment the value of the set speed
S9	Bucket	Setting of the rotor / bucket number
S10	At the same time	Switching between rpm and rcf display
S11	Time arrow down	Decrement the value of the set time
S12	Time arrow down	Increment the value of the set time
S13	Temp. Arrow down	Decrement the value of the set temperature
S14	Temp. Arrow up	Increment the value of the set temperature
S15	Frost	Pre cooling
S16	Double arrow	Quick run – hold button pushed
S17	Lid symbol	Open the lid
S18	Arrow right	Normal start of the centrifugation
S19	Red square	<b>Manual stop of a run</b>

#### Functions of Indicating Elements (Easycontrol)

Indicat.	Designation	Function(s)
H1	Buzzer	Audio signal
H2	Accel. curve digit	Display defined acceleration curves 1 to 9
H3	Decel. curve digit	Display defined deceleration curves 1 to 9
H4-H7, H12	Speed range	Speed in rpm (rounded to full 10 rpms) Rotor not yet detected (xxx „.“) rcf-value (xg) or not yet possible to calculate „-----“ Identifications no.'s of controller and NV-RAMs, Lid open condition („OPEn") Centrifuge run is terminated („End") Error messages („Lid“, „E-xx“, „bAL“, „rotor“)
H13-H15	Time range	Centrifugal time in h.min (count down process) Count up process (hld) in h.min (count up process) Actual version number („xx“)
H16,H17	Temperature range	Sample temperature in °C± 2K when pre-cooling or pre-heating process is terminated
H18	Allocation LED	For speed indication
H22	Allocation LED	For rcf indication
H19,20, 24,25	Rotation	Rotor spinning

### Key and Indication Board - Quickcontrol

The key and indication board is mounted behind the operating panel. The connection to the main board is done by a 4 pole cable by which the serial data transfer as well as the low voltage supply of 5V is verified. The 7-segment displays, the control LED's and the operating keys are managed by an own controller unit (first identification No. 591) in multiplex processing.

For the programming serves Knob control system Quickcontrol (see Operating Instructions)

#### Functions of keys elements (Quickcontrol)

Keys	Designation	Function(s)
S1	Adjusting knob	Set point temperature
S2	Adjusting knob	Set point time
S3	Adjusting knob	Set point speed
S6	Arrow up	Deceleration profile 1 to 3
S9	Bucket	Setting of the rotor / bucket number
S10	At the same time	Switching between rpm and rcf display
S16	Double arrow	Quick run – hold button pushed
S17	Lid symbol	Open the lid
S18	Arrow right	Normal start of the centrifugation
S19	Red square	<b>Manual stop of a run</b>

#### Functions of Indicating Elements (Quickcontrol)

Indicat.	Designation	Function(s)
H1	Buzzer	Audio signal
H3	Decel. curve digit	Display defined deceleration curves 1 to 3
H4-H7, H12	Speed range	Speed in rpm (rounded to full 10 rpms) Rotor not yet detected (xxx „.“) rcf-value (xg) or not yet possible to calculate „-----“ Identifications no.'s of controller and NV-RAMs, Lid open condition („OPEN") Centrifuge run is terminated („End") Error messages („Lid“, „E-xx“, „bAL“, „rotor“)
H13-H15	Time range	Centrifugal time in h.min (count down process) Count up process (hld) in h.min (count up process) Actual version number („xx“)
H16,H17	Temperature range	Sample temperature in °C± 2K when pre-cooling or pre-heating process is terminated
H18	Allocation LED	For speed indication
H22	Allocation LED	For rcf indication



### 3.4 Speed Detection Board

On a small board, which is attached underneath the motor, the circuits for speed detection and signal shaping are arranged. The motor speed is optically detected by an infra-red light barrier. The motor axle has a hole at the same level as the light barrier. This effects that the light beam will be interrupted twice during one motor revolution. A following pulse shaping stage on board forms square-topped pulses which are led via XW1 to the main board. The speed pulses are counted by the CPU to display the exact motor speed.

### 3.5 Rotor Indication

In the rotor's bottom 4 magnets are forced, being alternately arranged in polarity and positioned to each other to different distances on a constant circular ring (segment steps of 20°).

A Hall sensor is exactly fixed below to the sensor board. The magnets are switching a flip-flop stage by which different pulse lengths and pulse intermissions are generated during one rotor rotation. By this signal the CPU is able to detect up to 65 different rotors and the correct direction of rotation, too.

### 3.6 Imbalance Detection

On the speed detection board a piezoelectric acceleration detector is additional fixed. Dependent of the rotor imbalance this sensor generates an analogous voltage signal which is led via a following band-pass filter to plug connection XW1/2 to main board, where it is analysed by CPU. When the CPU has identified the installed rotor type, the speed dependent imbalance limitation curve from E-PROM The analogue imbalance signal is filtered, converted into digital form and continuously compared with this specific limitation curve. If the actual imbalance signal will rise at any speed beyond the limit, the error signal for imbalance load "bAL" will be displayed and the unit slows down.

### 3.7 Lid lock system

The latch is directly controlled by CPU via a PWM motor driver. If all necessary signals are existing which allow an opening the motor is fired with a pulsed voltage of 24 VDC. For additional safety the relay K2 will be activated if the speed is below 120 rpm controlled by triggered mono-flops.

### 3.8 Cooling plant

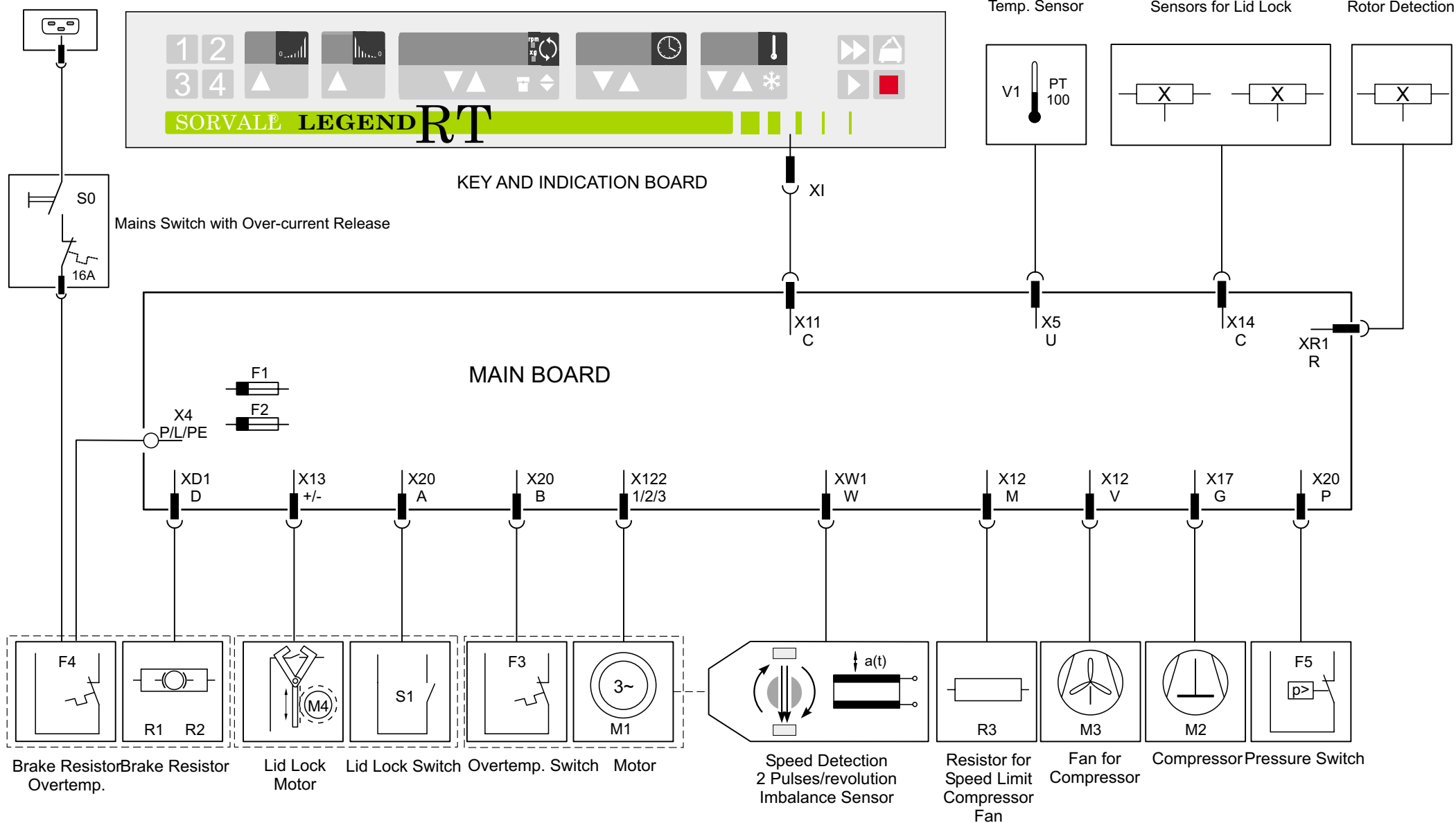
The Multifuge 3SR/LR, Legend RT is equipped with a high-grade cooling plant, to meet it's requirements of driving power and compact design. The CFC free refrigerant R404A evaporates at low temperatures ( $\leq -20^{\circ}\text{C}$ ) and absorbs through this the frictional heat from chamber produced by the fast spinning rotor. 5 fans serve for even air flow through condenser so that the refrigerant's condensing temperature is kept on a low level (lateral front fans are only switched on, if  $n > 0$  rpm).

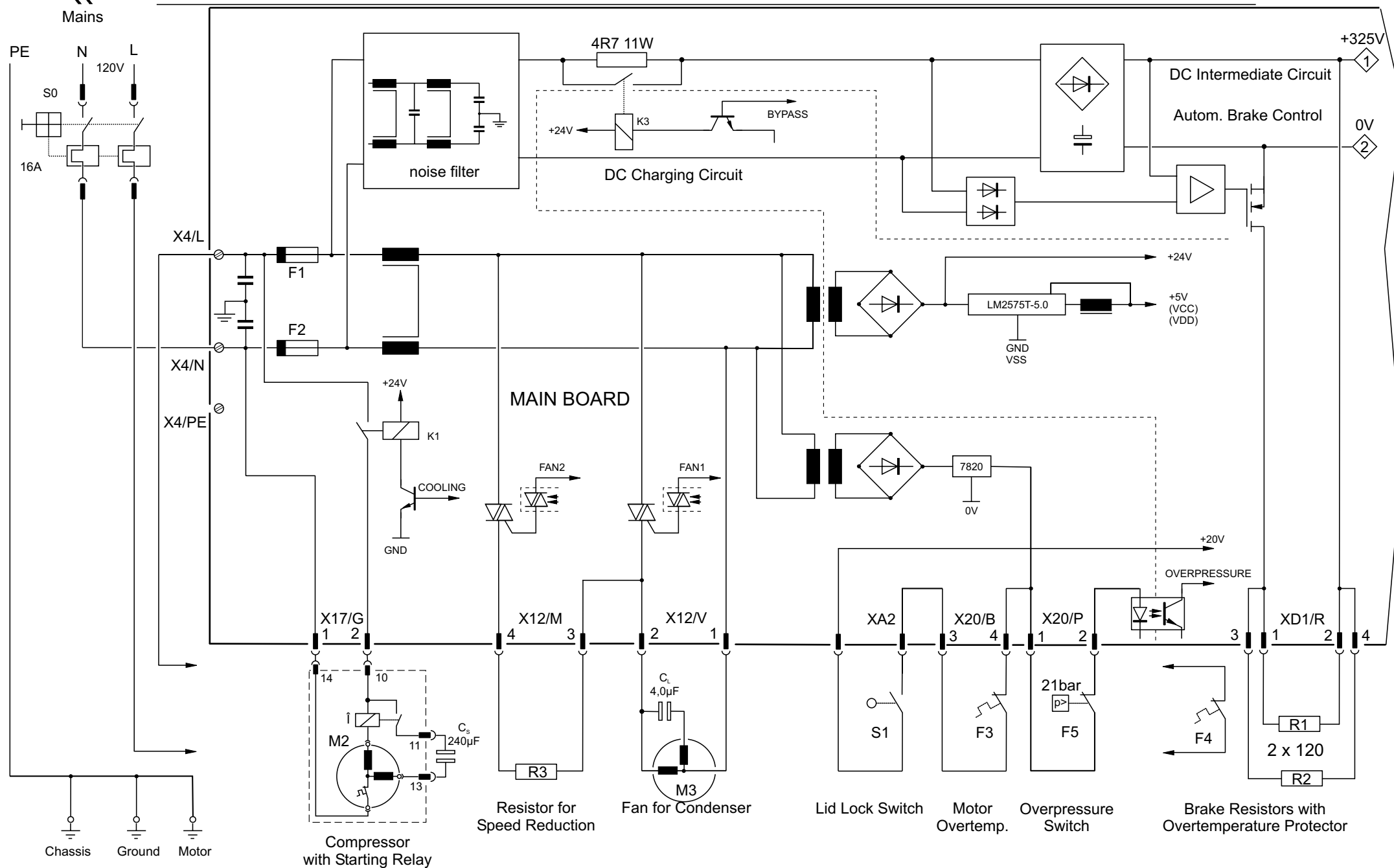
A specially designed coaxial heat exchanger serves for essential undercooling of the condensed refrigerant to ensure an optimum evaporation and a perfect operation of the expansion valve. To maintain low evaporation and resultant condensation temperatures on one hand and to support the starting procedure of the compressor on other hand, a thermostatic expansion valve with 3.0bara MOP is used.

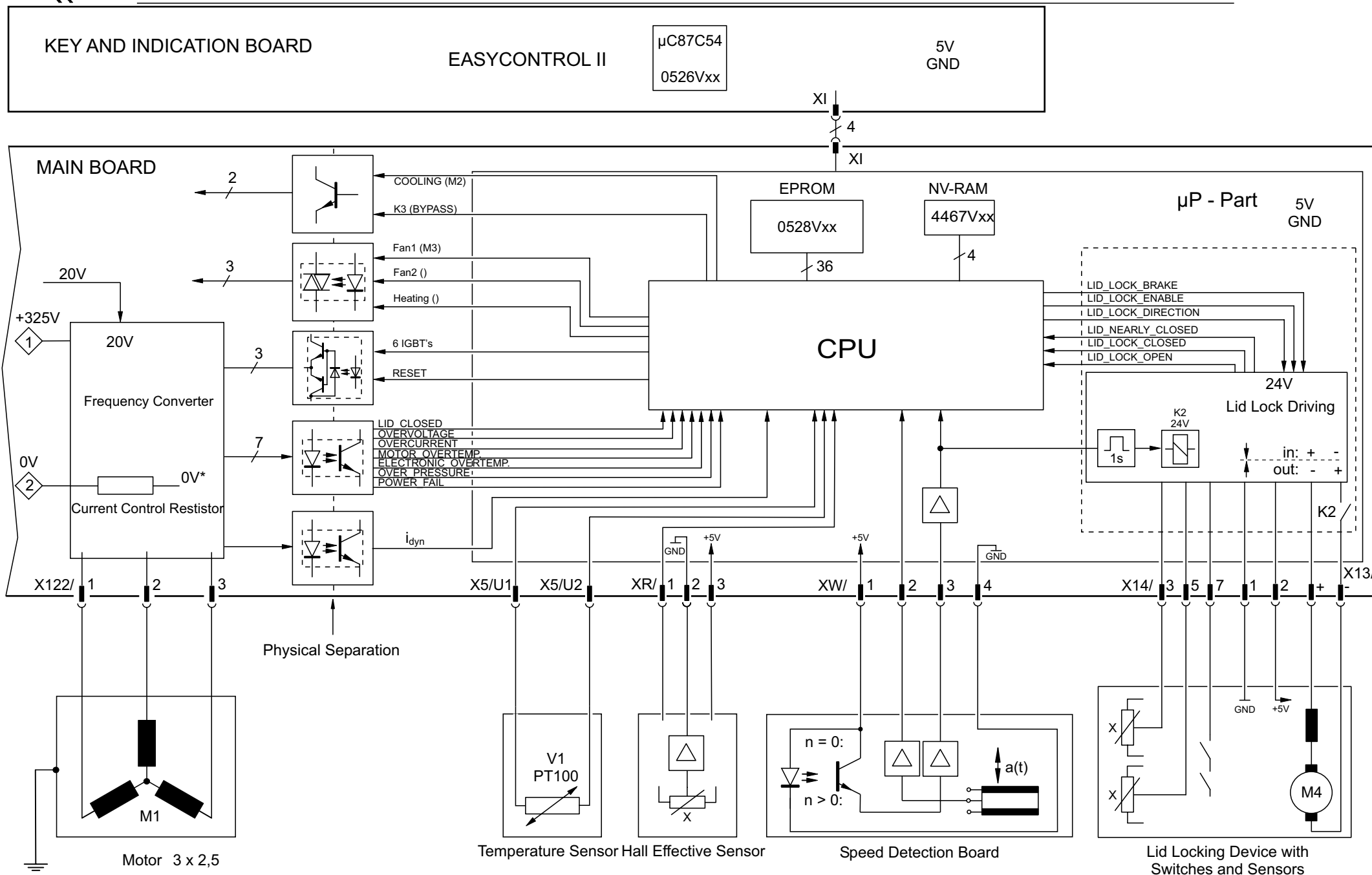
The minimum achievable sample temperatures are depending on speed, rotor type and a little on ambient temperature. After a compensating time, given by the pre-cooling or pre-heating program as optimal result, the rotor has reached the selected set temperature within a tolerance of  $\pm 2\text{K}$ .

To reduce the power consumption of the unit the compressor will not be activated during accelerating of the motor. When reaching the selected speed the compressor will be activated if a low temperature had been selected.

Unit's Plug







① PCB Rotor Detection (fill up)

② PCB Speed and Imbalance Detection  
(under the motor)

③ Motor

④ Pt100 Temperature Sensor

⑤ Switch at the left Lid Lock

⑥ Motor for Lid Lock

⑦ Switch Lid Lock

⑧ PCB Sensors for Lid Lock

⑨ Resistor for Fan

⑩ Mains Input

⑫ Start Capacitor

⑬ Relay for Compressor

⑭ Toroidal Core with  
2 electrical windings

⑮ Compressor

⑯ Over Pressure Switch

⑰ Brake Resistor

⑱ Temperature Fuse

⑲ Condenser

⑳ Fan for Condenser

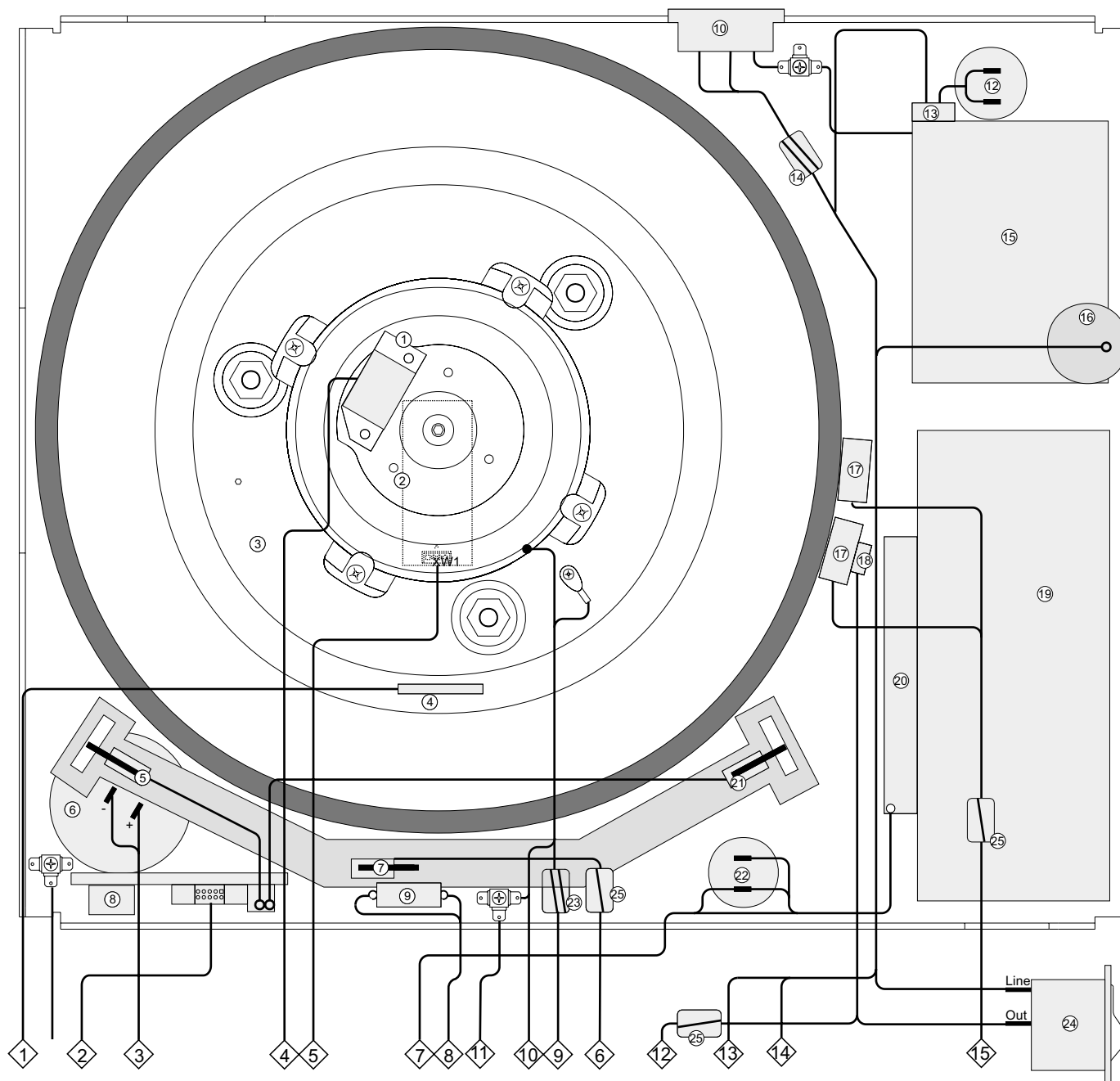
㉑ Switch at the right lid lock

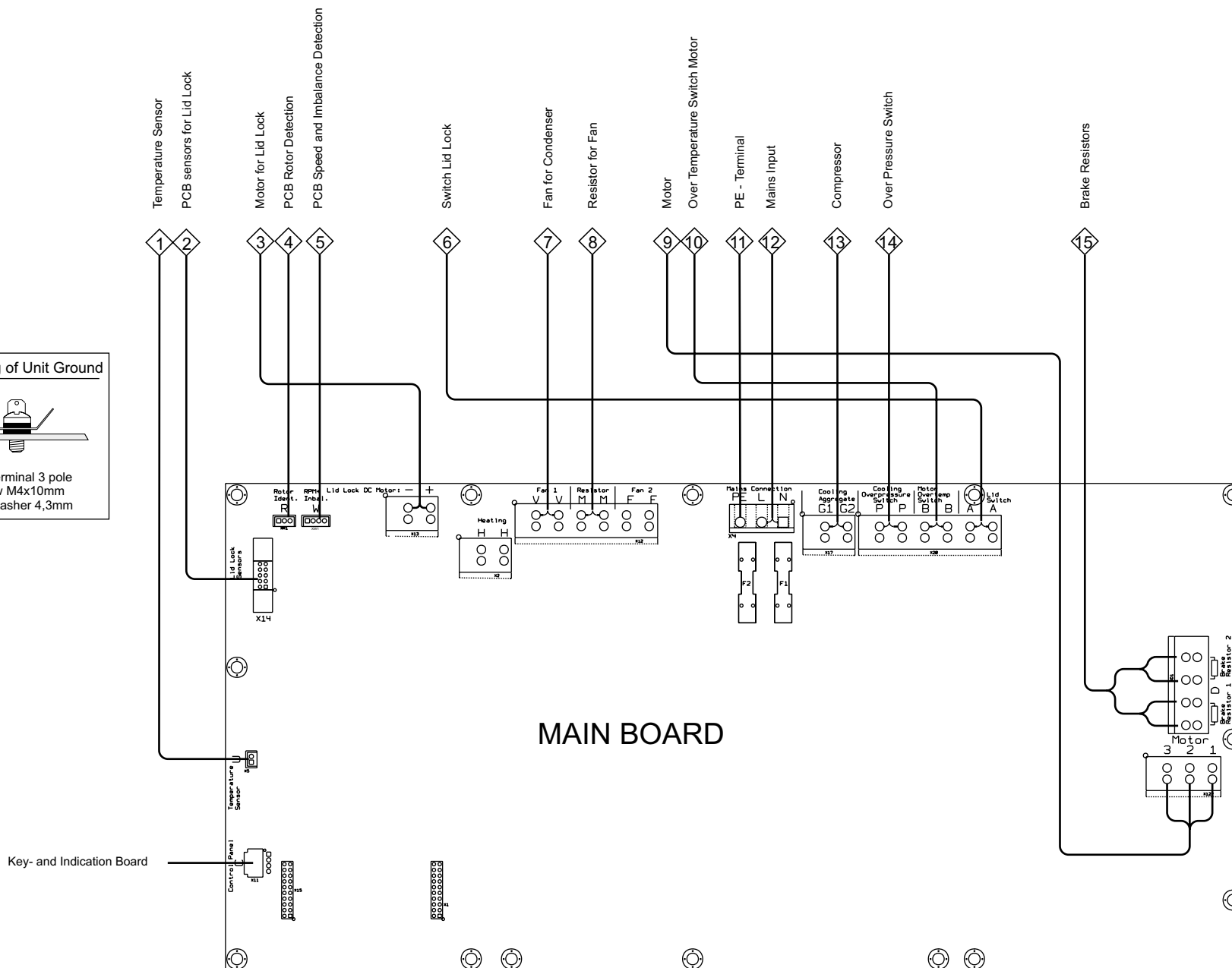
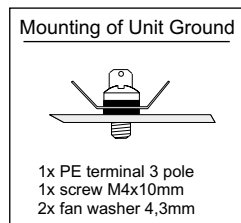
㉒ Capacitor for Fan

㉓ Toroidal Core with  
2 electrical windings

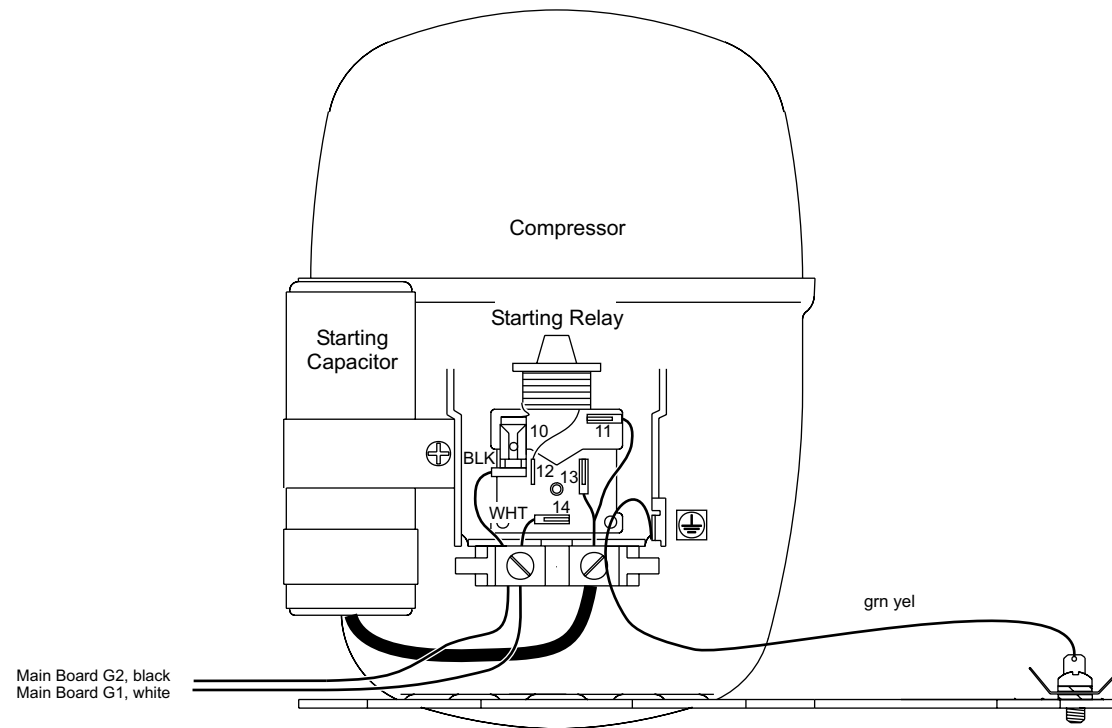
㉔ Mains Switch

㉕ Toroidal Core with  
1 electrical winding

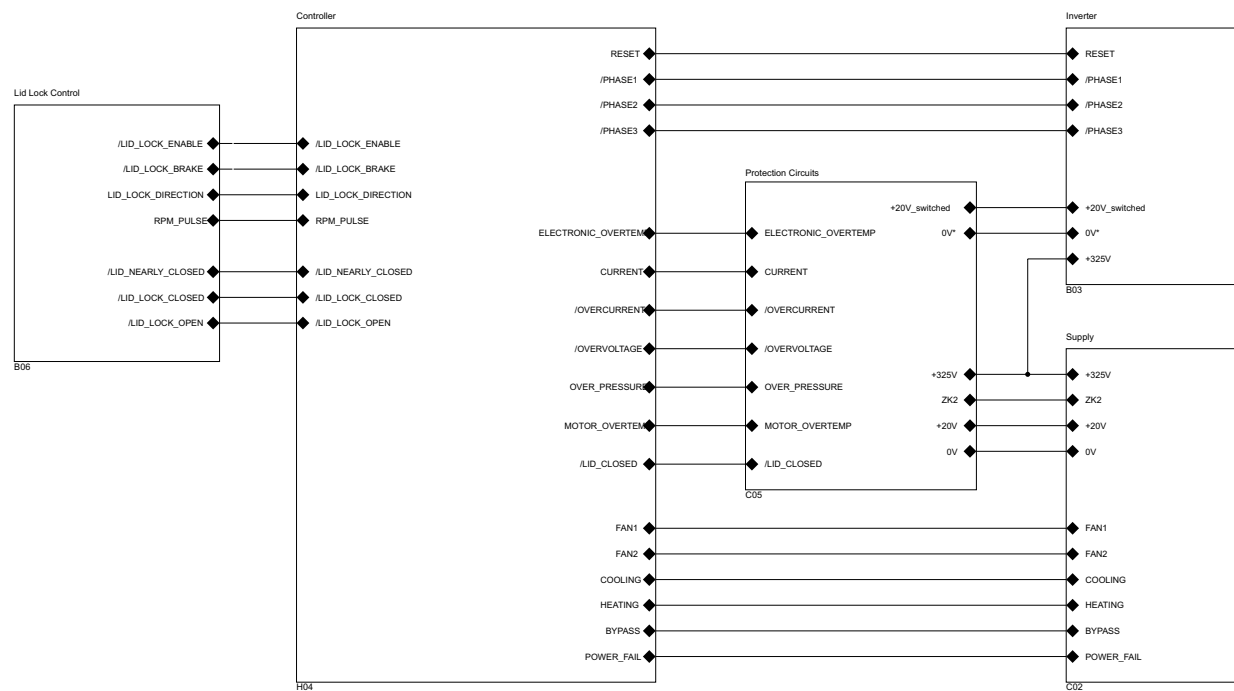




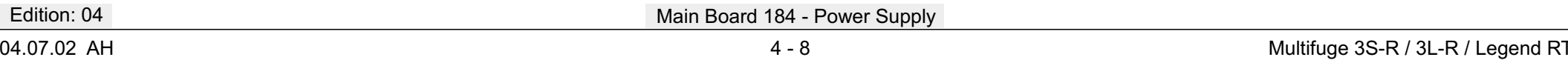
Connection Diagram Compressor

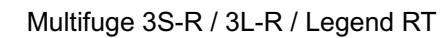


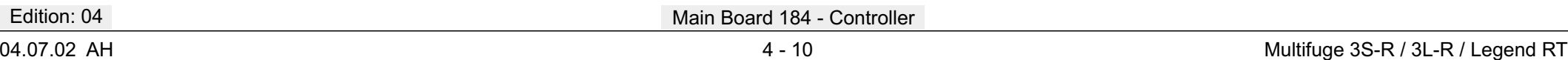
Main Board G2, black  
Main Board G1, white

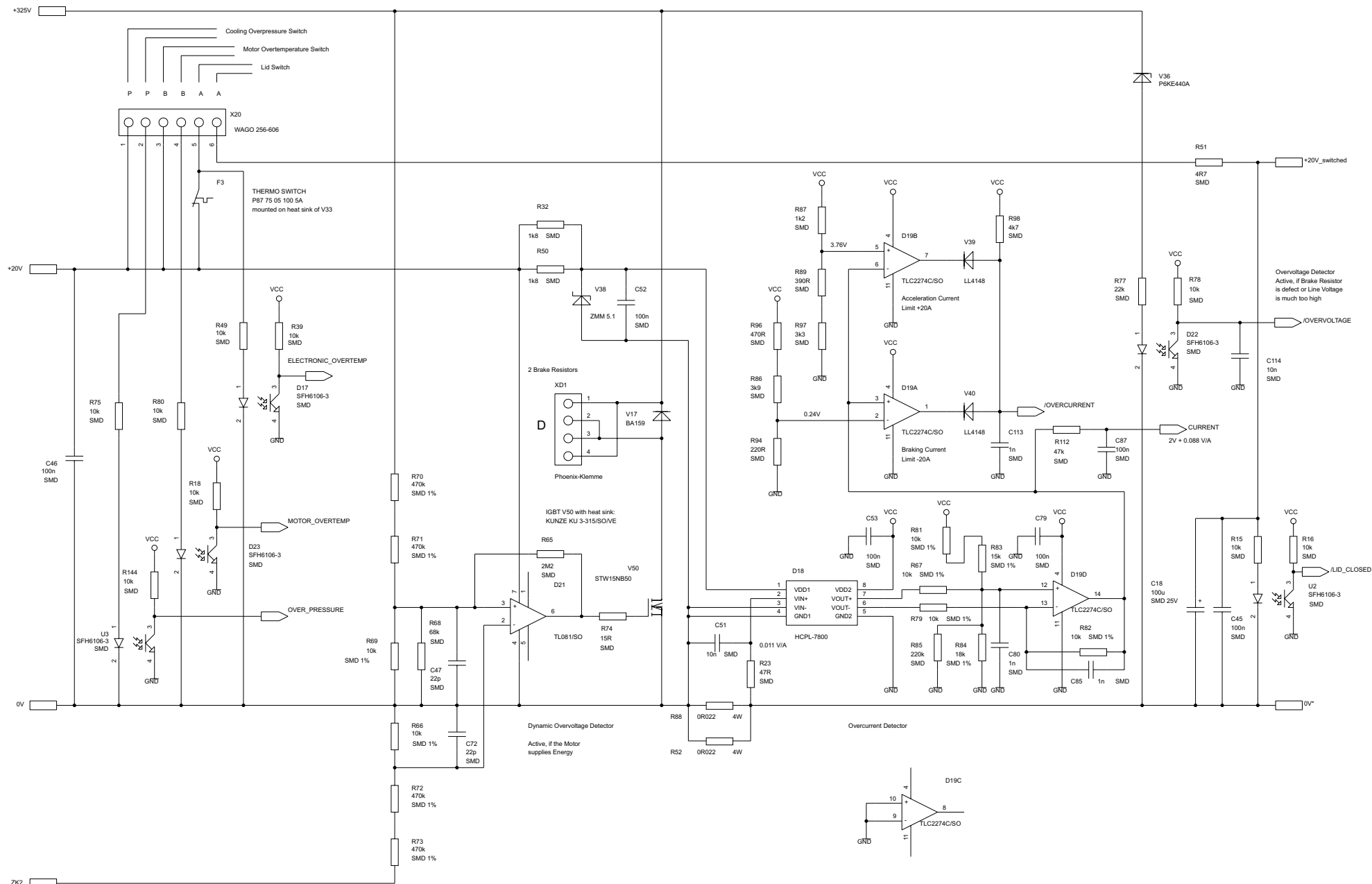


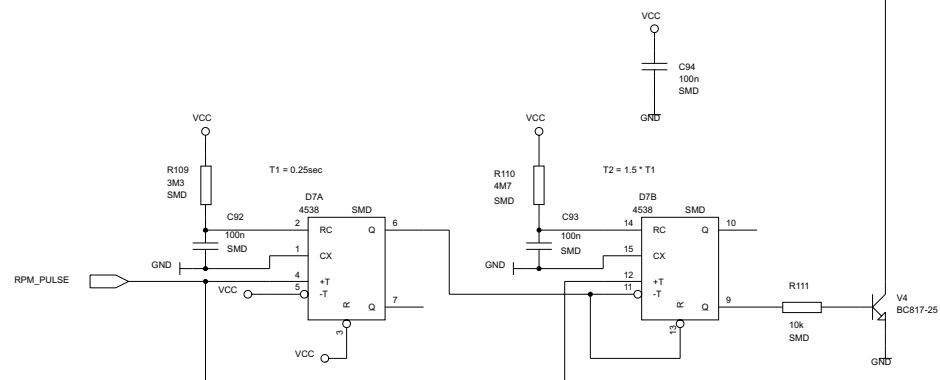




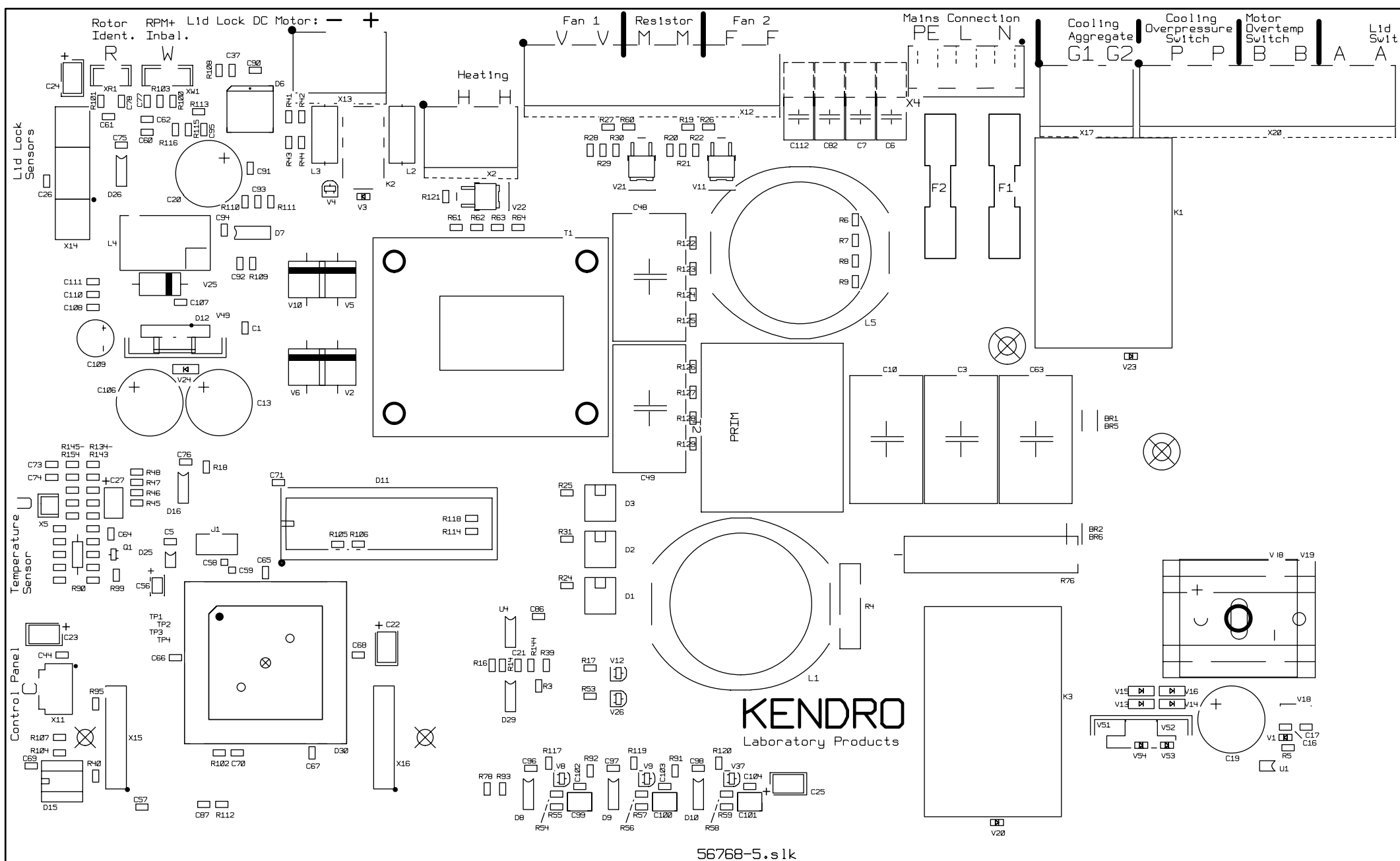


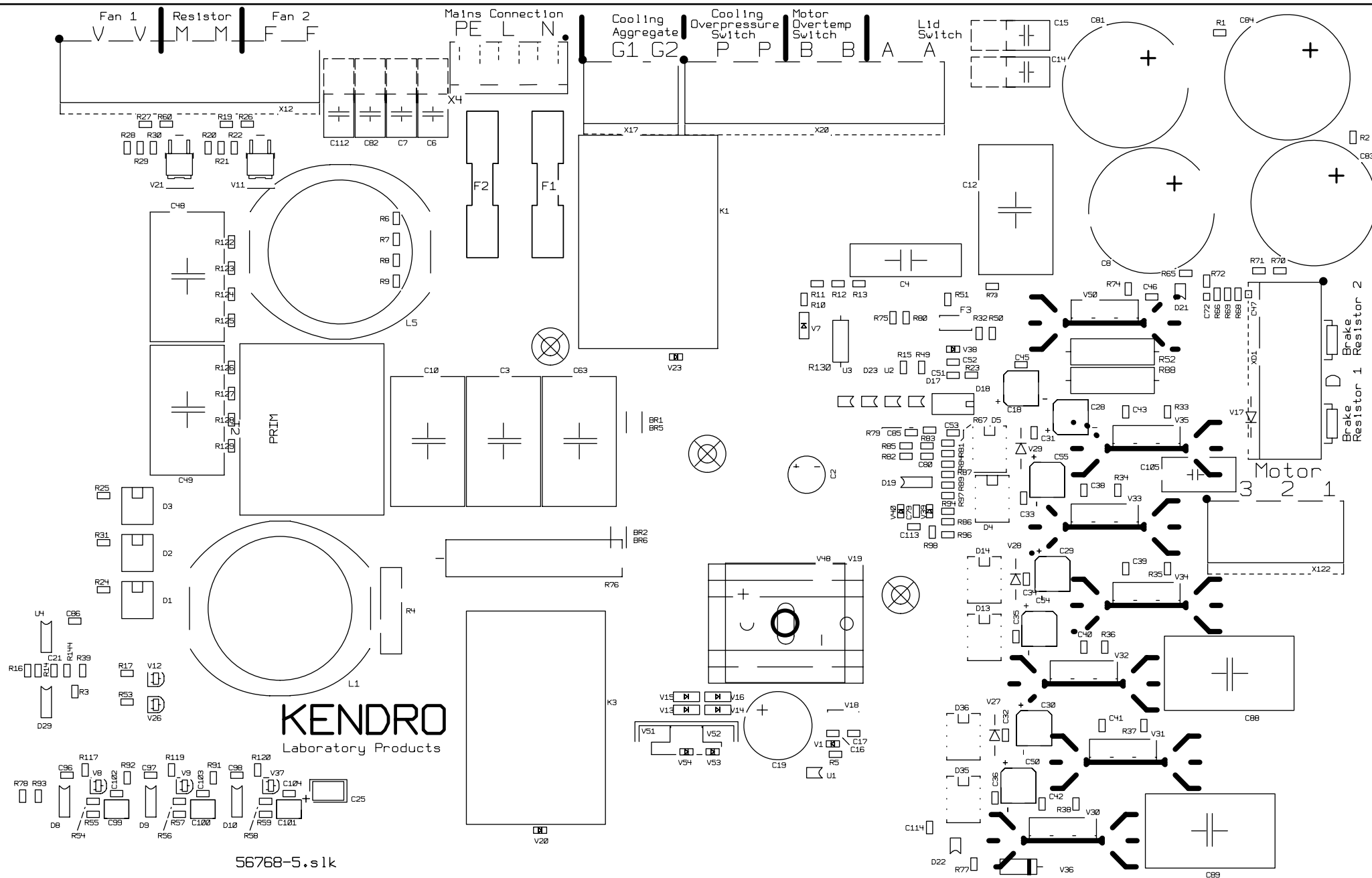


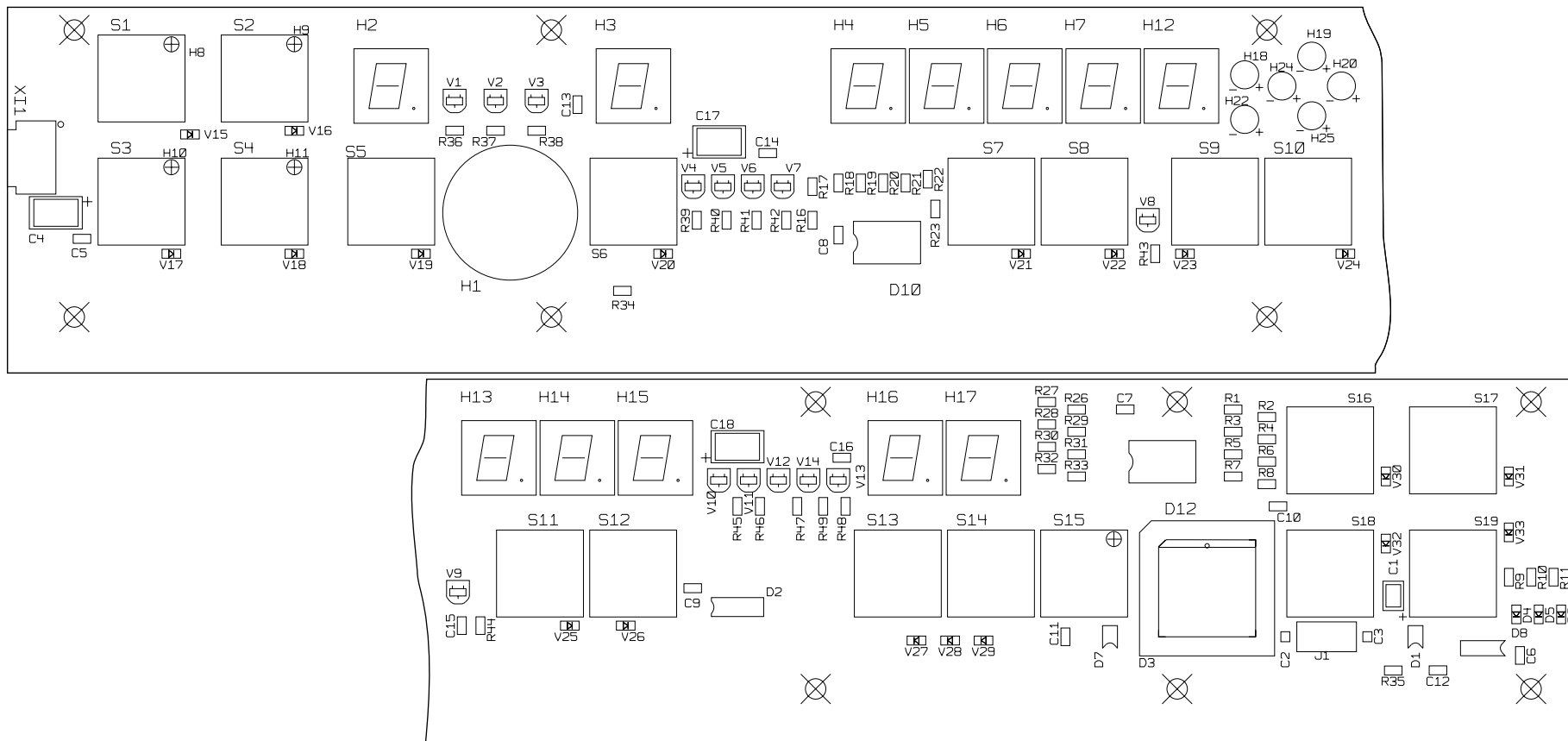




Speed	Pin 6	Pin 9
0	Low	High
<120RPM	Pulse	High
>120RPM	High	Low

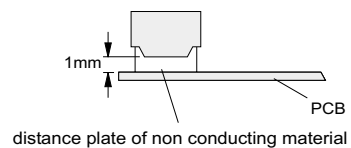






### Seven segment LEDs

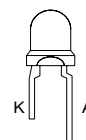
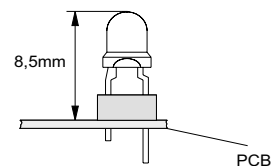
Seven segment LED



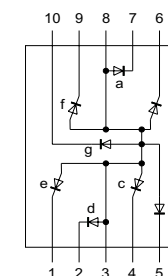
### LED's

LED's HLMP on sockets  
with pins to top

Line verification of HLMP 3mm

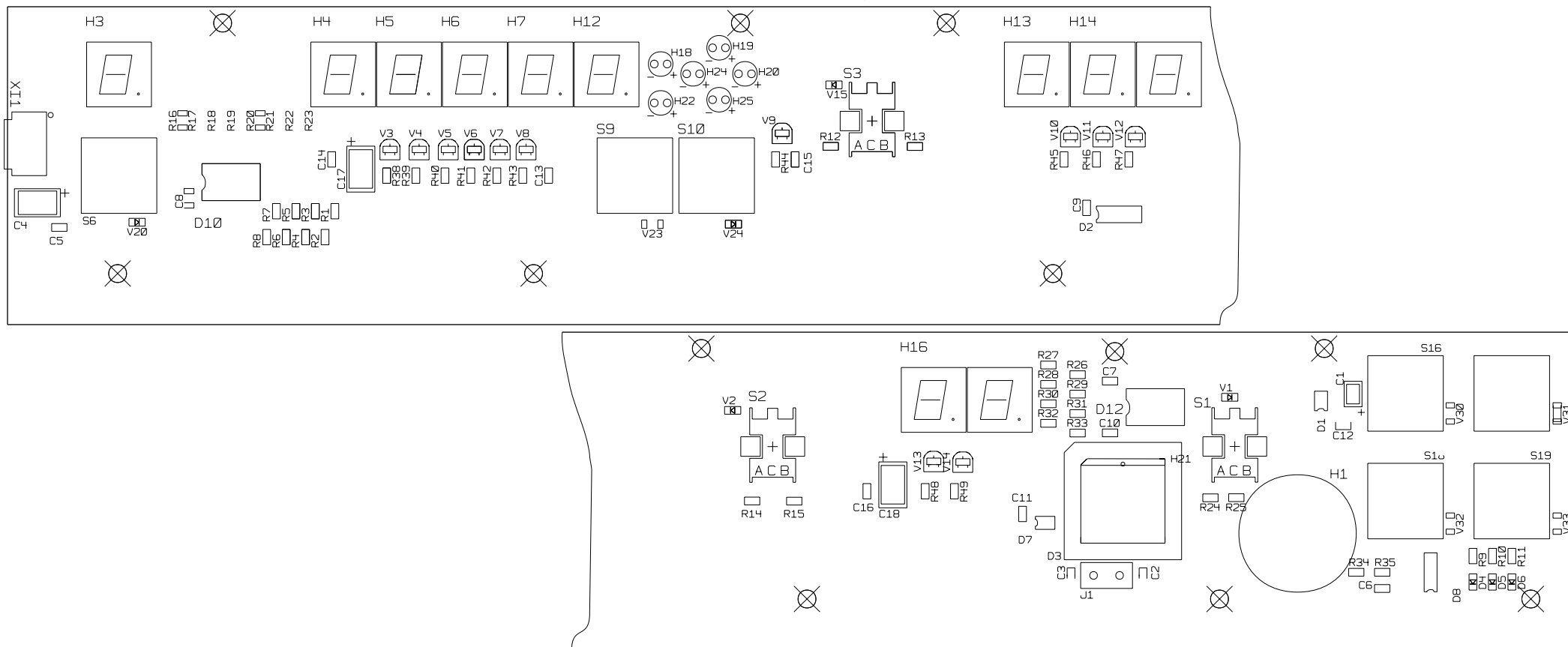


Top view  
TDSG 5150-M

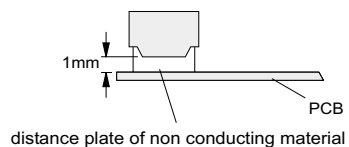




Drehknopf - Version / Rotary switch version



Seven segment LED

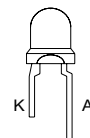
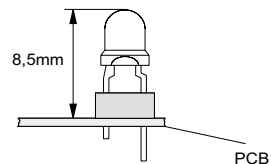


Seven segment LEDs

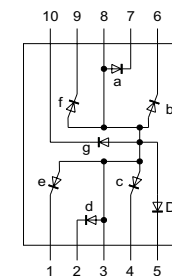
LED's

LED's HLMP on sockets  
with pins to top

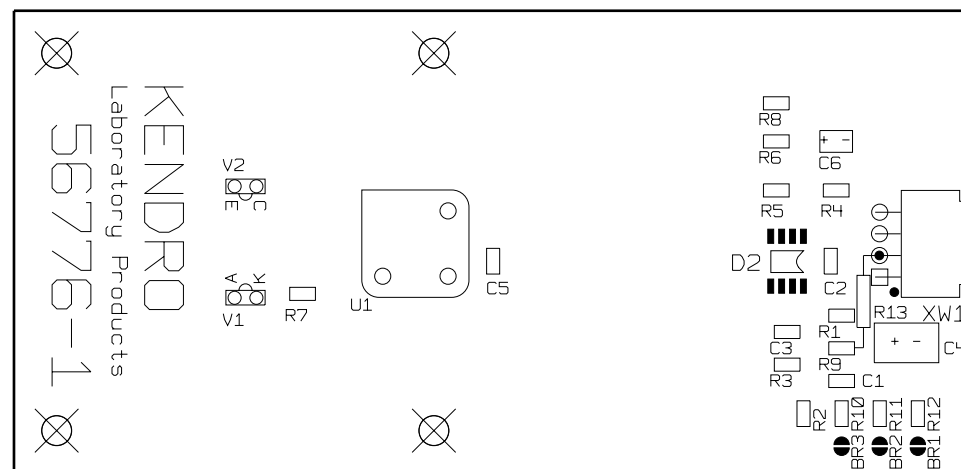
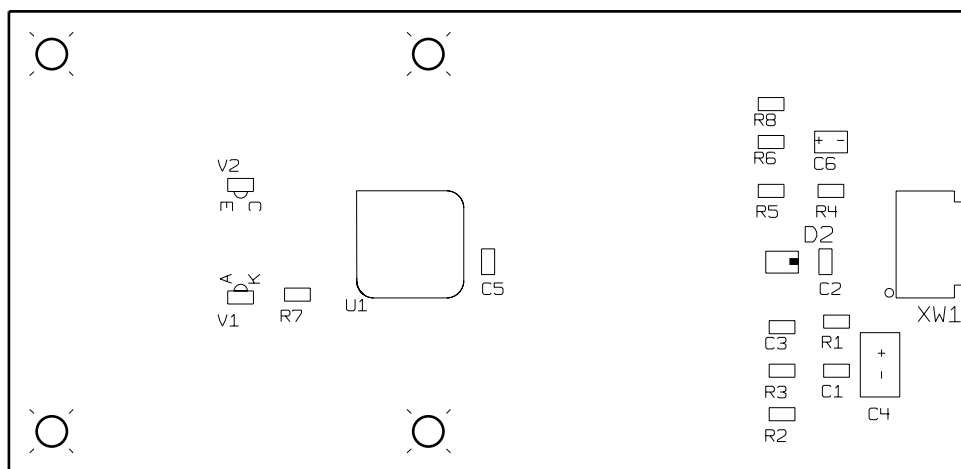
Line verification of HLMP 3mm



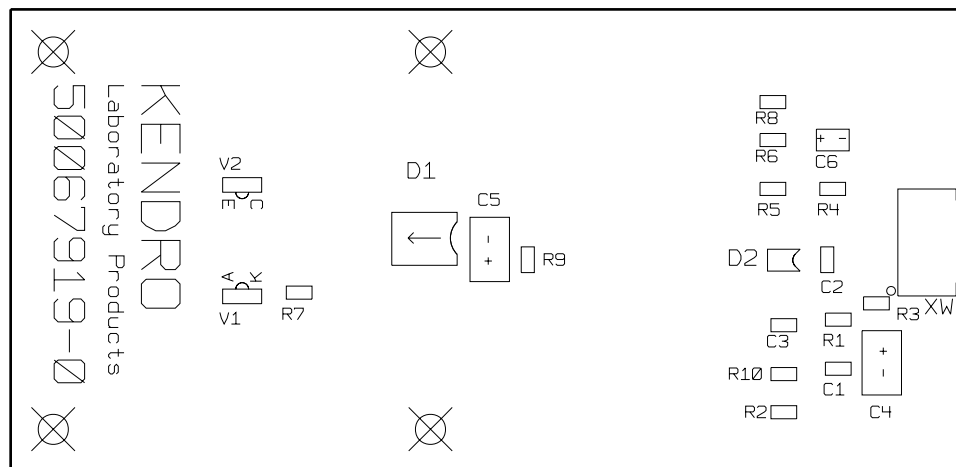
Top view  
TDSG 5150-M

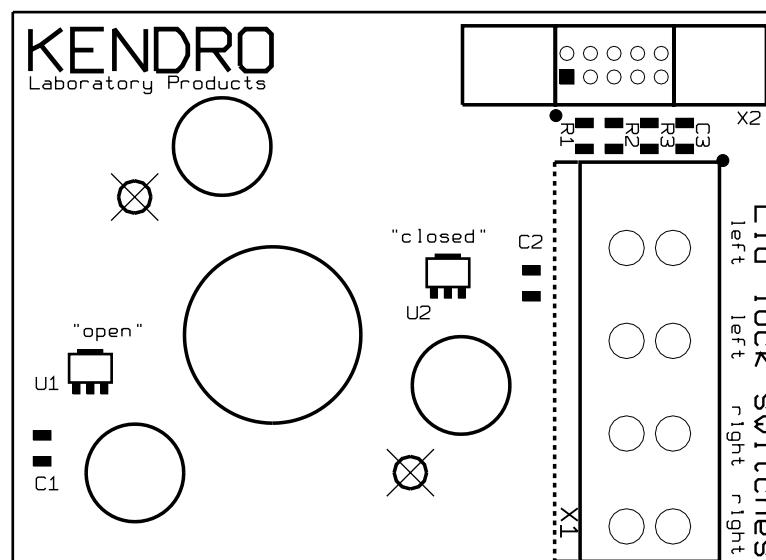
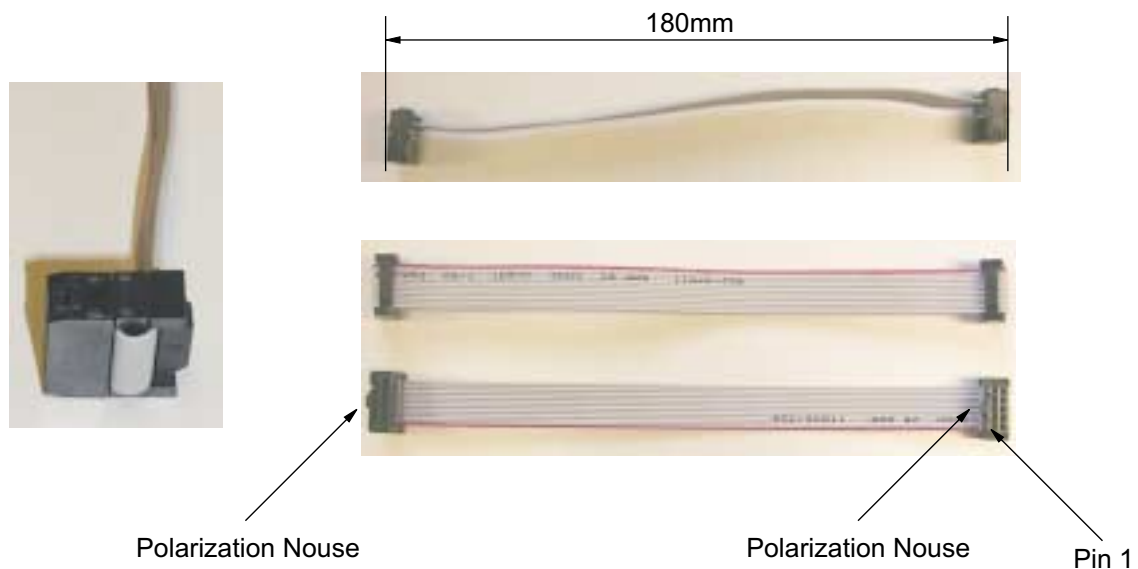


Speed and Imbalance Detection Board P/N 70902651

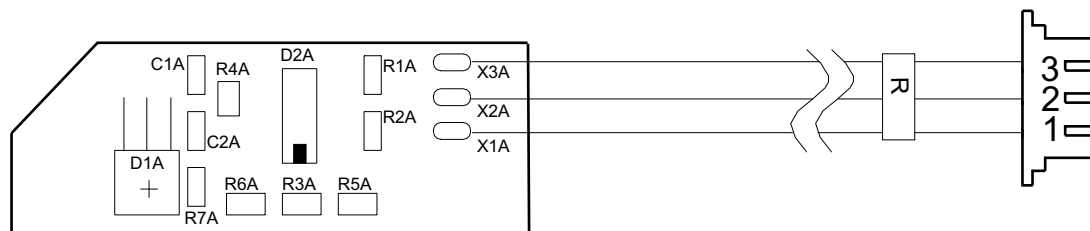


Speed and Imbalance Detection Board P/N 20150214

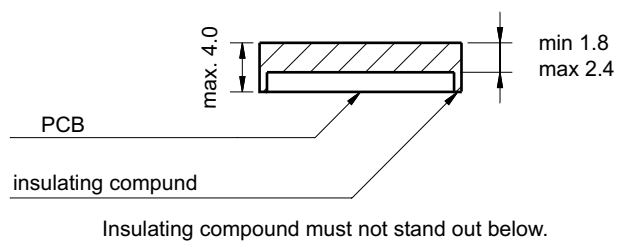
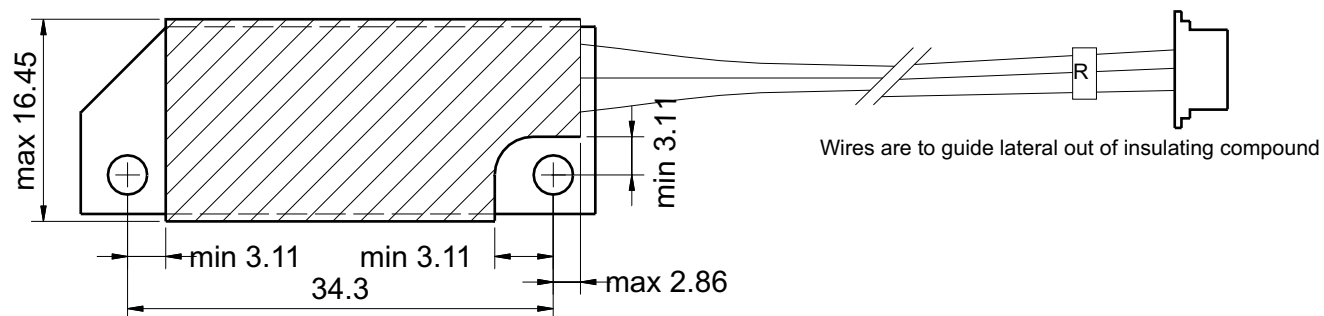


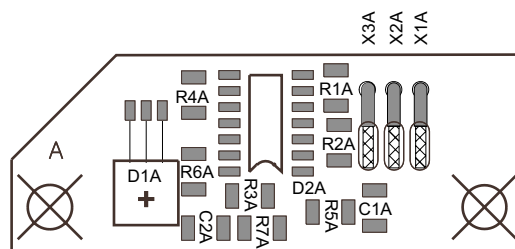


Old version of PCB

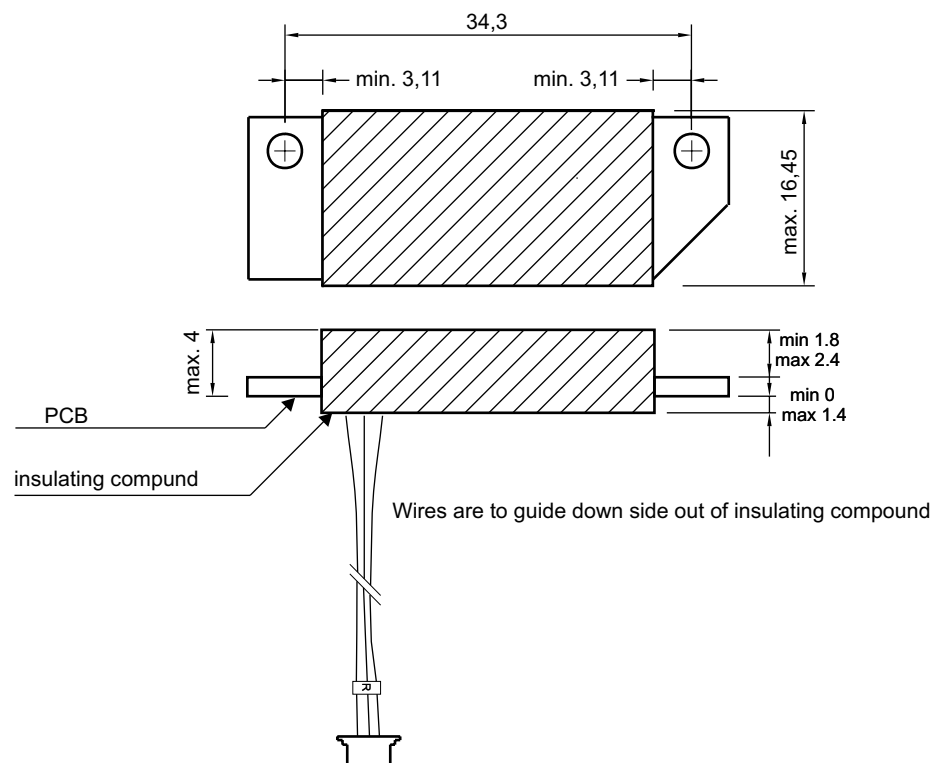


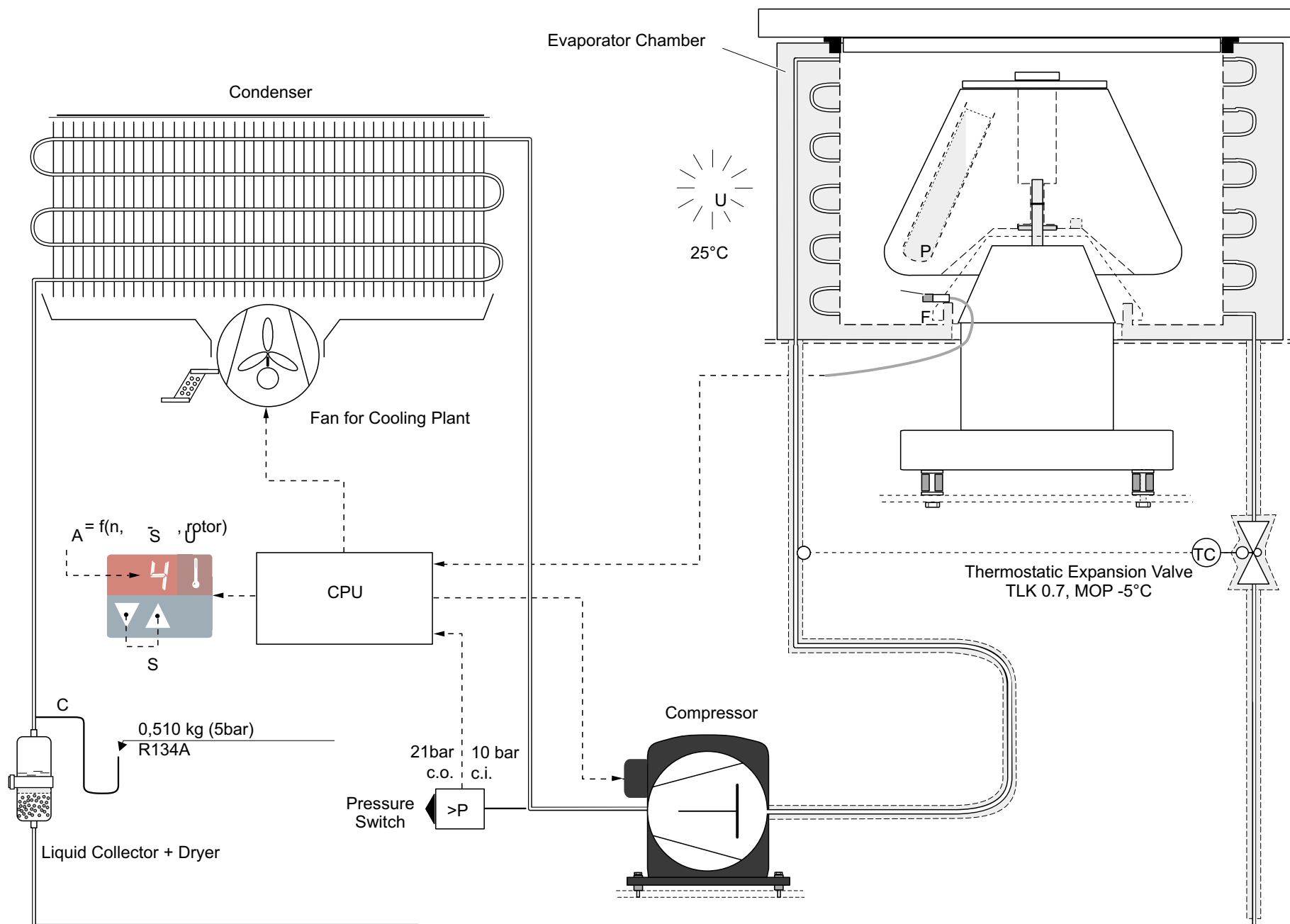
Dimensions of cast PCB





Dimensions of cast PCB





The index numbers stated in ( ) reappear within the spare part figures (block diagram, schematic diagram of cooling plant) and the spare part lists. Due to cooled and non-cooled version are described not all parts can be available.

## 5.1 Dismantling the Housing

### 5.1.1 Front Panel (800)

- Open the lid, switch off the unit and **pull out the mains plug**
- Remove screws underneath of the front-panel
- Move the panel right or at newer units, to the top and take it off
- Disconnect wiring from display board

### 5.1.2 Lid (620)

- Open the lid, switch off the unit and **pull out the mains plug**
- Knock carefully the joint bolts (511) for upper attaching of gas lid stays (515) out of joint blocks (610) **with its three notches ahead** by use of a hammer and pin punches (but press the bolts in with non notches ahead by use of pliers)
- Push an adequate screw driver into one bolt's place to keep the gas lid stay in position to avoid lid's slamming
- Remove the 6 screws for lid's attaching on both hinges
- Take the screw driver out of joint blocks to separate lid from gas stay and remove the lid from casing
- When reassembling the lid take care that both bolt keepers (605) engage the lock entries concentric and stand out of the screw-in hollow exactly for 36mm

### 5.1.3 Casing (500)

- Remove the front panel (800) - see 5.1.1
- Remove the lid (620) - see 5.1.2
- Remove main board – see 5.2.2
- Remove the 4 remaining screws on both sides
- Disconnect the grounding line and remove the casing with lid (500) and bolt holes sealing in vertical position from armoured chamber and frame
- Reassemble the casing analogously in reverse order and take care of the correct lid sealing seat (320)

### 5.1.4 Automatic Lid Locking System (475)

- Dismantle the front panel (800) - see 5.1.1
- Dismantle main board – see 5.2.2
- Disconnect plug X13 turn the motor with help of an auxiliary voltage DC 12V into a position that you can remove the 3 screws
- Remove lower nut of the latch holder bar
- Remove latch holder bar
- Disconnect wiring of micro switches and flat cable on PCB attached to gear motor
- Remove 4 set screws (2 x 2) in positioner
- Reinstall the latch and gear motor in reverse order
- Make sure that the center micro-switch is proper adjusted
- Move latch to the maximum top position, loose the two screws of micro switch move it until it "clicks"
- Check by driving the latch up and down with help of auxiliary voltage

#### 5.1.5 Gas Lid Stays (515)

- Open the lid, switch off the unit, **pull out the mains plug** and remove the rotor
- Remove the lid - see 5.1.3
- Remove the casing - see 5.1.4
- Remove the attaching screws for the lower joint blocks
- Knock carefully the joint bolts (511) for lower attaching of gas lid stays (515) out of joint blocks (610) **with its three notches ahead** by use of hammer and pin punches (but press the bolt in with non notches ahead by use of pliers)
- Replace both worn out gas lid stays and reinstall the new gas lid stays analogously in reverse order and remount the unit completely.

### 5.2 Replacement of Electrical Components

#### 5.2.1 NV-RAM, E-PROM on the Main Board

- Notice old displayed identification and version numbers of E-PROM and NV-RAM when powering on (2./3. No. in sequence)
- See wiring diagram and remove the front panel (800) - see 5.1.1
- Remove main board - see 5.2.2
- **ATTENTION - CMOS components! Discharge your body before handling!** Pull CPU and/or NV-RAM carefully out of socket using chip removal tool
- Reinsert the new IC's correctly
- Put the front panel back in position, switch power ON, check the displayed identification and version numbers of the new ICs and refit the front panel

#### 5.2.2 Main Board Replacement (700)

- dismantle the front panel (800) - see 5.1.1
- Remove the screws which fasten the board and place it in front of the unit
- Remove all wires from the terminals by pressing the lever. Unplug **XC, XR, XU\*, XW**. Only the main cable is fastened in a screwed terminal.
- **touch a grounded receptacle to discharge your body before touching the sensitive CMOS components!** Take the new CPU and/or NV-RAM out of box (or re-use the old ones when in **perfect** condition) and insert them into sockets of the new main board (if necessary, remove the placed but non-programmed NV-RAM before)
- remount the new main board with all nuts and washers
- **Do not mix up disconnected cables during re-connection!**
- Reassemble the device in reverse order and perform a test run, **making sure the drive turns in the right direction** (see imprinted arrow on rim of rotor chamber)!

#### 5.2.3 Key and Display Board (810)

- Remove the front panel (800) - see 5.1.1
- Remove the attaching screws and take out the indication board
- Unplug the connecting line to main board and transfer to new board
- Reassemble the indication board analogously in reverse order, check controller identification and refit the front panel

#### 5.2.4 Rotor Indication Board (137)

- The sensor board is placed on the motor and fixed at the pins with Loctite. It can be easily removed by pulling carefully.



#### 5.2.5 Speed Detection Board (140)

- Remove the drive with mounting plate - see 5.3.2 and deposit upside down
- Remove the screws and lock washers and take out the board
- Unplug the connecting line to main board and transfer to new detection board
- Remount the speed detection board (plug position: left to back), reassemble the unit analogously in reverse order and perform a test run

#### 5.2.6 Fans

- **Condenser fan, right side: (235):**
- Remove front panel see 5.1.1
- Remove main board see 5.2.2
- Take fan apart

#### 5.2.7 Brake Resistor (255/256)

- Remove front panel - see 5.1.1
- Remove the main board – see 5.2.2
- Remove housing only in case of resistor change
- Check the resistance of both brake resistors and replace defective resistor(s)
- Check thermos switch on R 2
- Check the cleanliness of air louvers and clean them if necessary, pay attention to good heat transmission
- Reassemble the device analogously in reverse order. Perform some short test runs with max brake curve.

### 5.3 Replacement of Drive Components

#### 5.3.1 Drive Motor (135)

- Remove Motor cover with sensor cover
- Remove the front panel and main board - see 5.1.1 and 5.2.2
- Disconnect the leads for motor X122 (**U,V,W**), over temperature switch **X20**, unplug the grounding wire **PE** from casing's receptacle
- Remove ferroxcube from the motor wires in front safety chamber and tie a string for easier pulling afterwards
- Remove rotor recognition board and put it on side
- Remove temperature sensor (if available)
- Unscrew motor take it off
- Remove speed detection board and reinstall it at the new motor

#### 5.3.2 Motor rubber Mounts (104)

- Remove motor – see 5.3.1
- Place unit on 4 blocks of wood (10 to 15 cm)
- Remove 10 screw underneath base plate
- Base plate will not come off
- Turn the base plate 1,5 cm until the holder screws allow to remove the plate
- Inspect the rubber mounts and if necessary replace them
- All 6 rubber mounts must only be exchanged completely!
- Take care that the safety screws will not be damaged or loosen (non-cooled version only)

### 5.3.3 Adjustment of the micro switch (center of Latch system)

- Remove front-panel and main board see 5.1.1 and 5.2.2
- Move the latch sleigh to the maximum top by help of auxiliary voltage
- Loosen the two screws of the micro-switch and move it in a position that a clear click can be heard + 0,5 to 1mm – check with multimeter for zero ohm
- Connect motor to power supply and make sure that the switch is functioning well
- Secure the bolts with paint

## 5.4 Replacement of Parts of the Cooling Plant\*

First of all is to figure out that high ambient temperatures ( $\vartheta_U > 35^\circ\text{C}$ ), insufficient heat transfer (e.g. polluted condenser, de-heater, air gaps) or electrical errors (like defective fans, sensor or main board, starting relay or capacitor) can be excluded from the cooling problem (see function diagram of cooling plant 4-10: pressure / temperature ranges are valid for continuous cooling at max. speed,  $\vartheta_U = 25^\circ\text{C}$ )!

Procedure for replacing defective components of the cooling cycle:

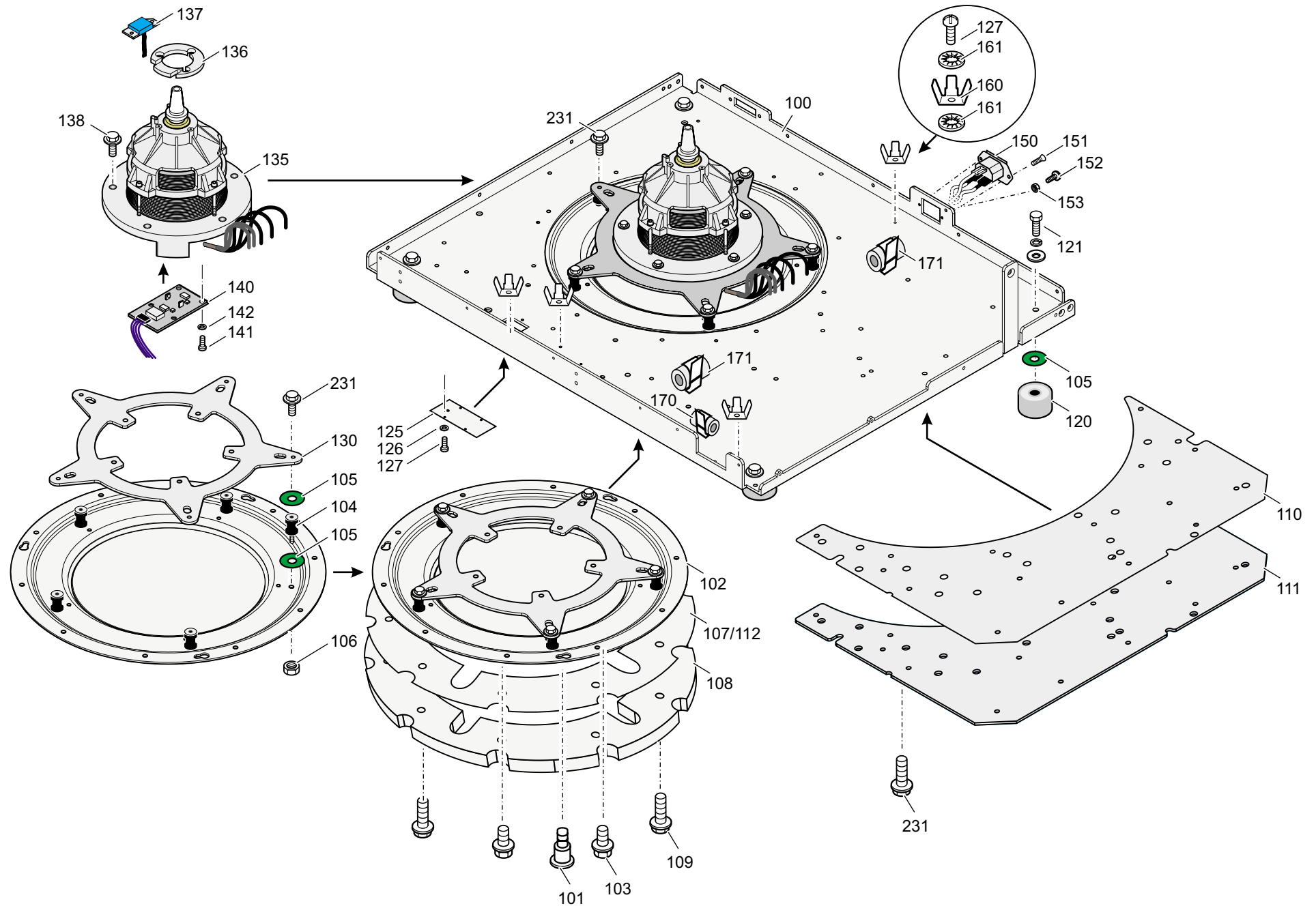
- Dismantle the casing -see 5.1. and mount pierce valves onto the service lines
- When gauging too little static pressure perform a leakage test ( $\text{N}_2$  max. 25bars)
- Discharge the refrigerant with suction device into recycling bottle
- In case of compressor (200) fault, let the oil run out into a bowl to recycle it
- Unsolder defective component(s) and replace the dryer/collector assy (235), too
- Let a little amount of dry nitrogen gas stream through the tubes when soldering to avoid scaling on the tube's inner surface
- Do the evacuation and refill the system with the exact amount of liquid refrigerant on the pressure side via a new external dryer (check amount with a balance or filling cylinder, re-solder the service lines tight after finishing work)
- Reassemble the device and perform a cooling power test run.

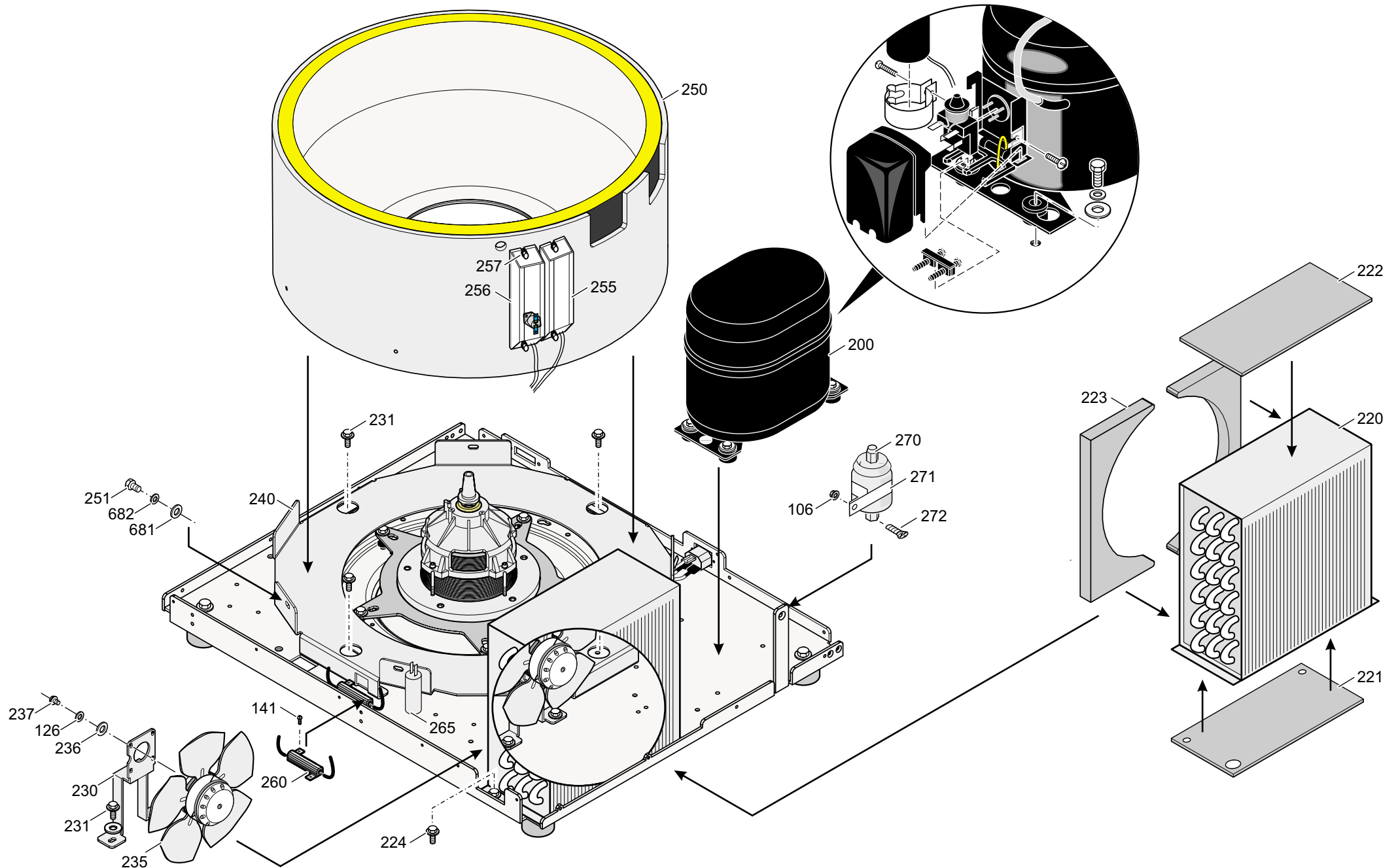
### Charging information 120 V version:

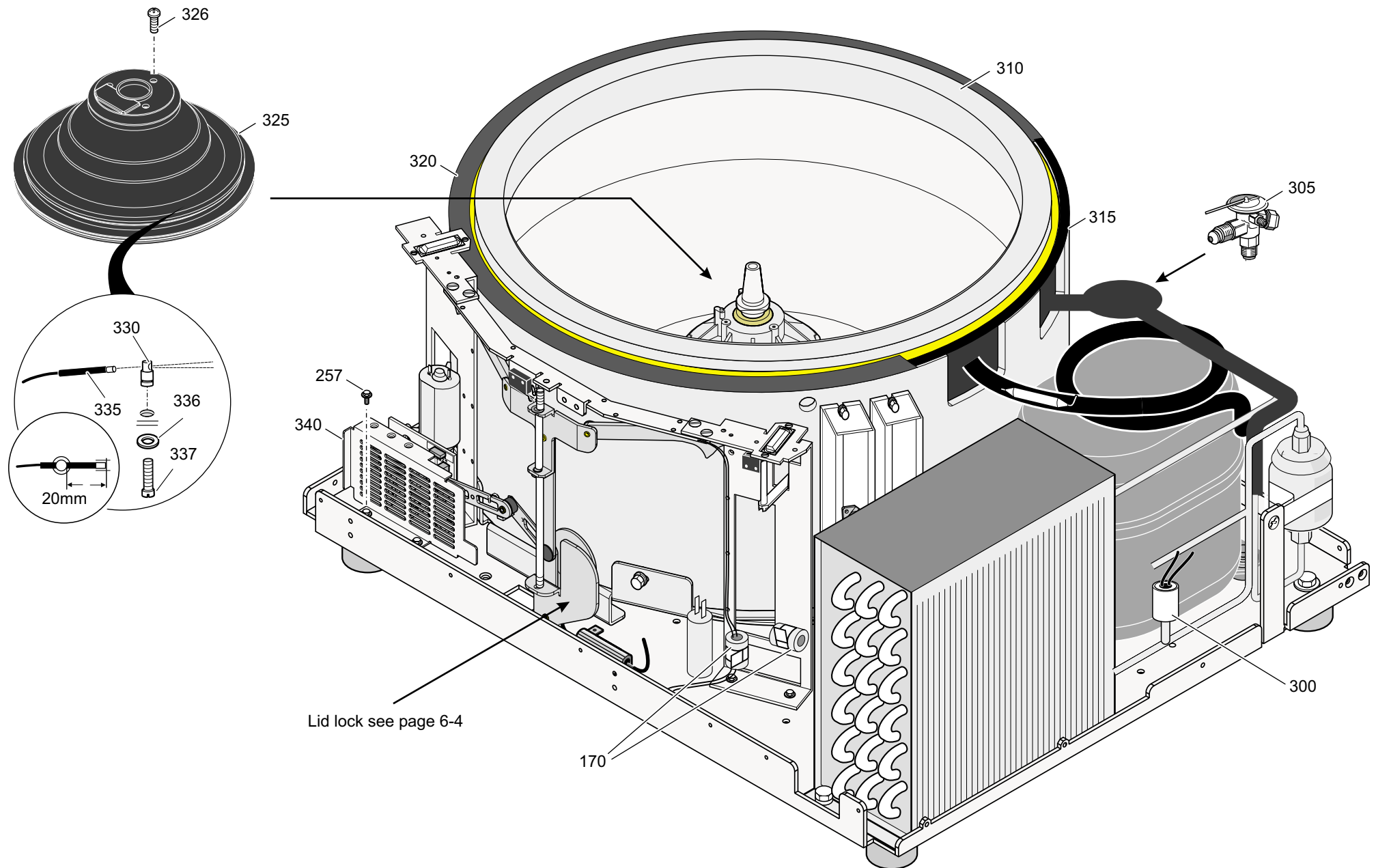
Refrigerant: R 134a  
Amount: 510 grams (17,8 oz)

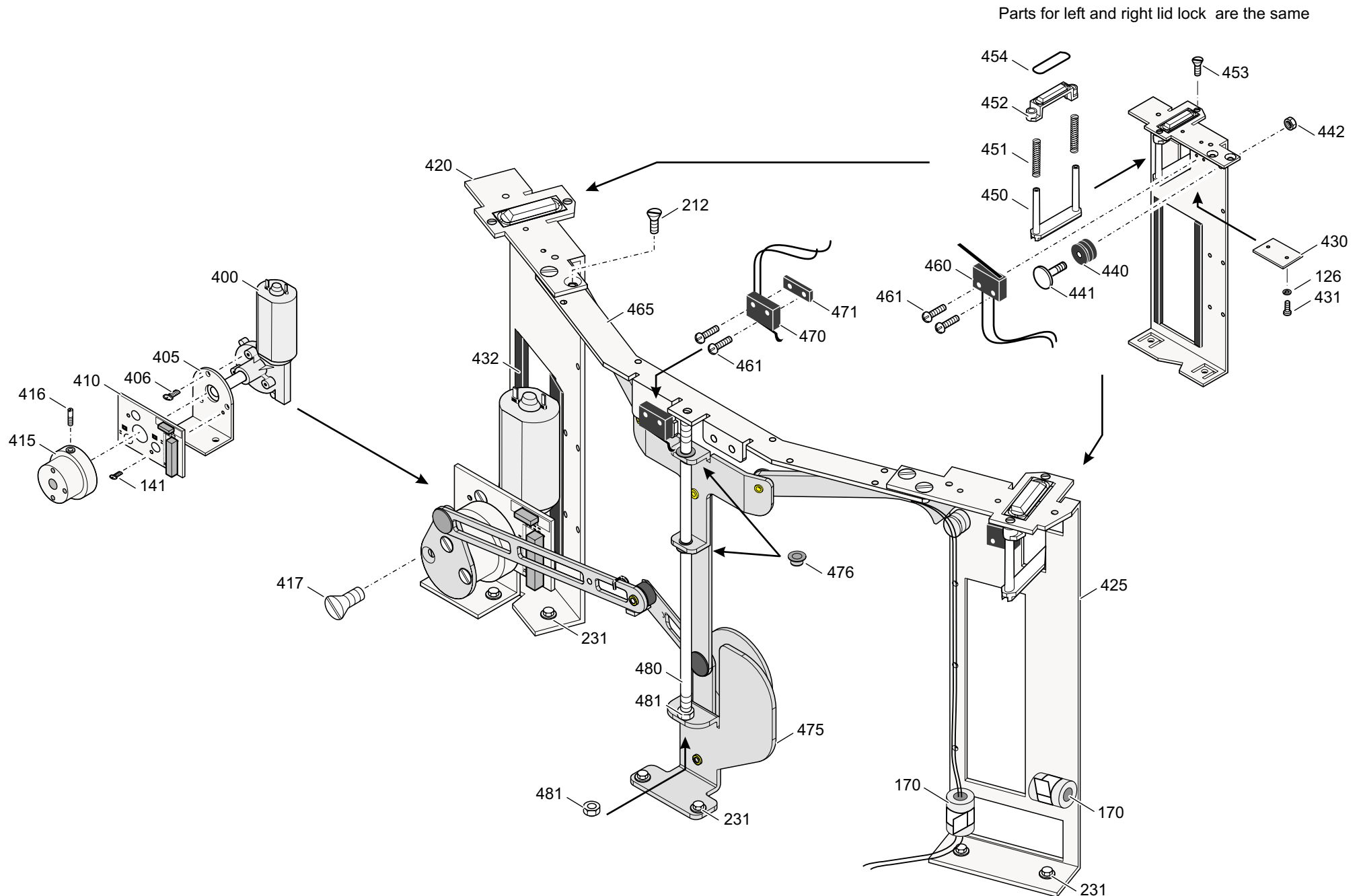
### Operating pressure with rotor 75006445 and round buckets 75006441, n = 3750 rpm

Ambient:  $23^\circ\text{C}$  ( $73^\circ\text{F}$ )  
Temperature selection: minimum  
Time: 3 hours  
Suction: 1,9 +/-0,1 bars ( $-12^\circ\text{C}$ ) 27,15 psi  
Discharge: 7,5 bars ( $30^\circ\text{C}$ ) 107,2 psi



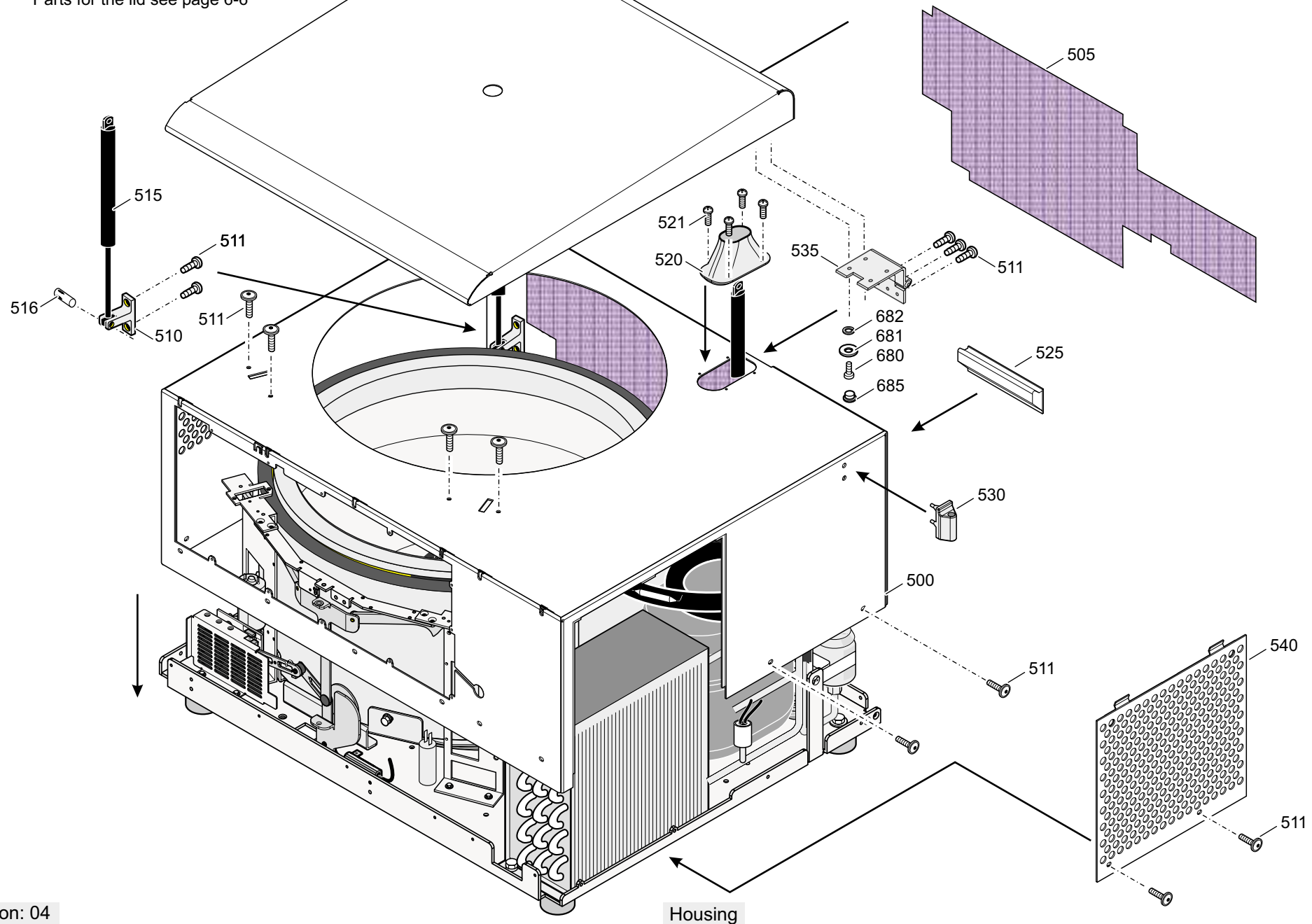


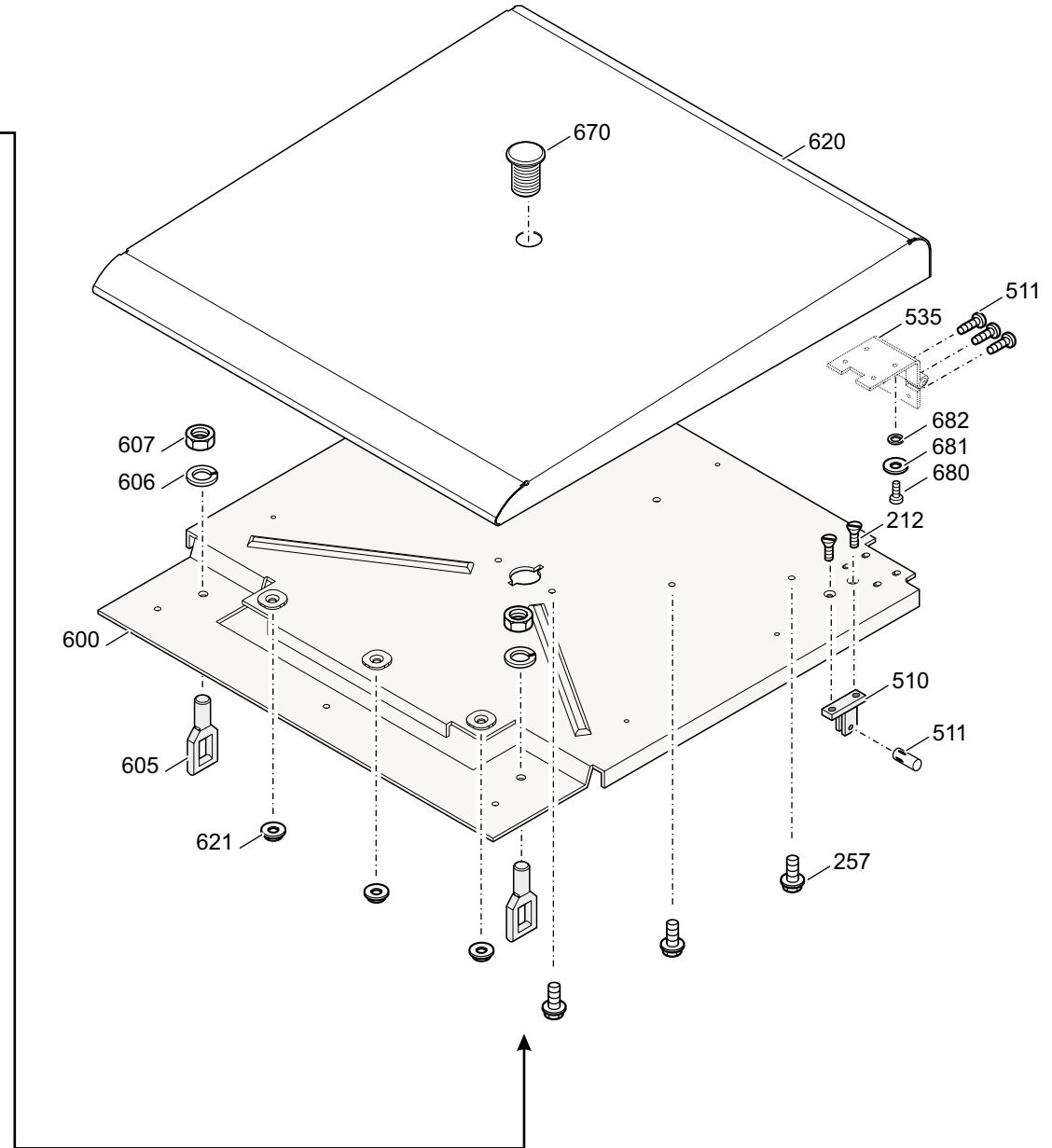
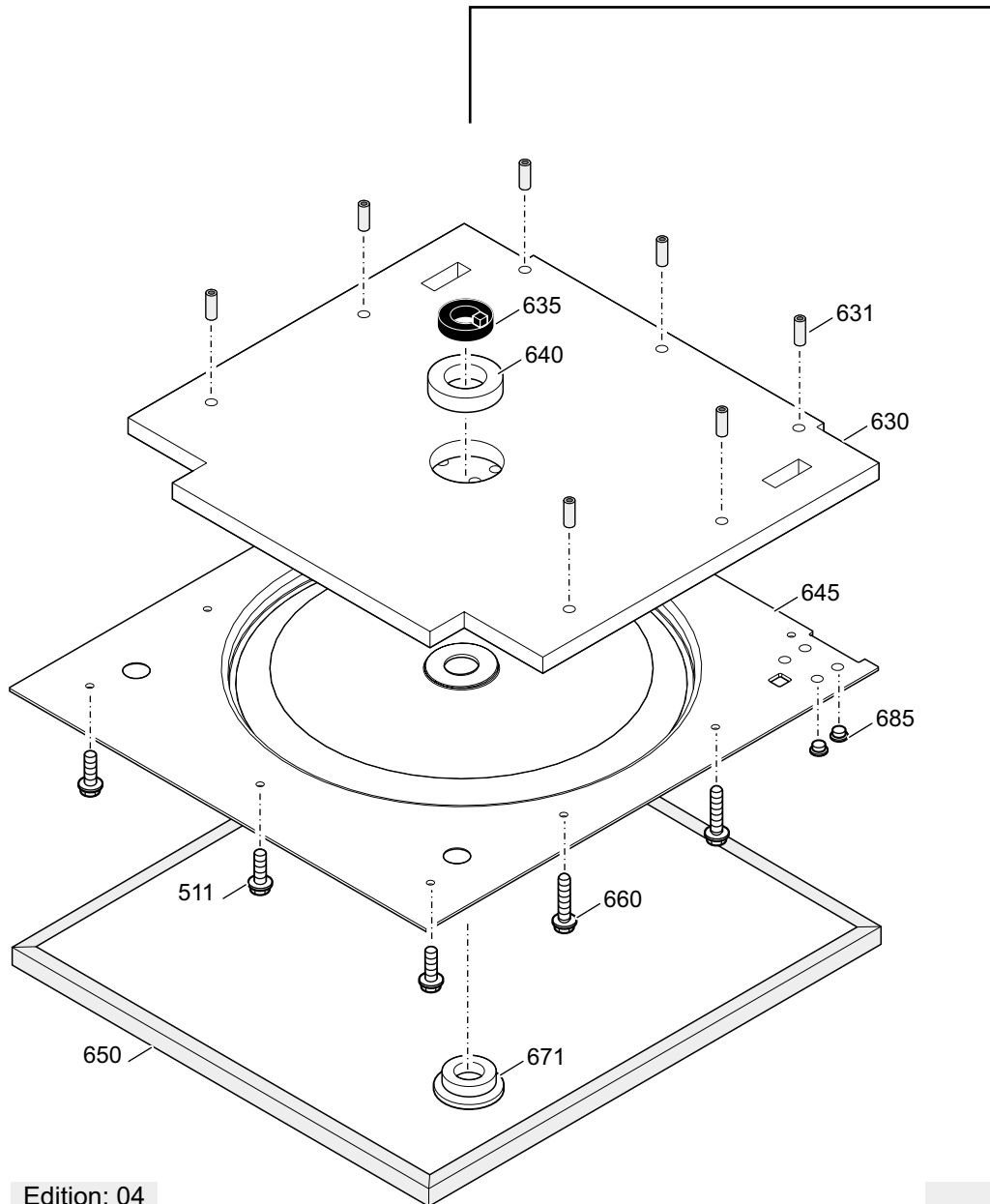




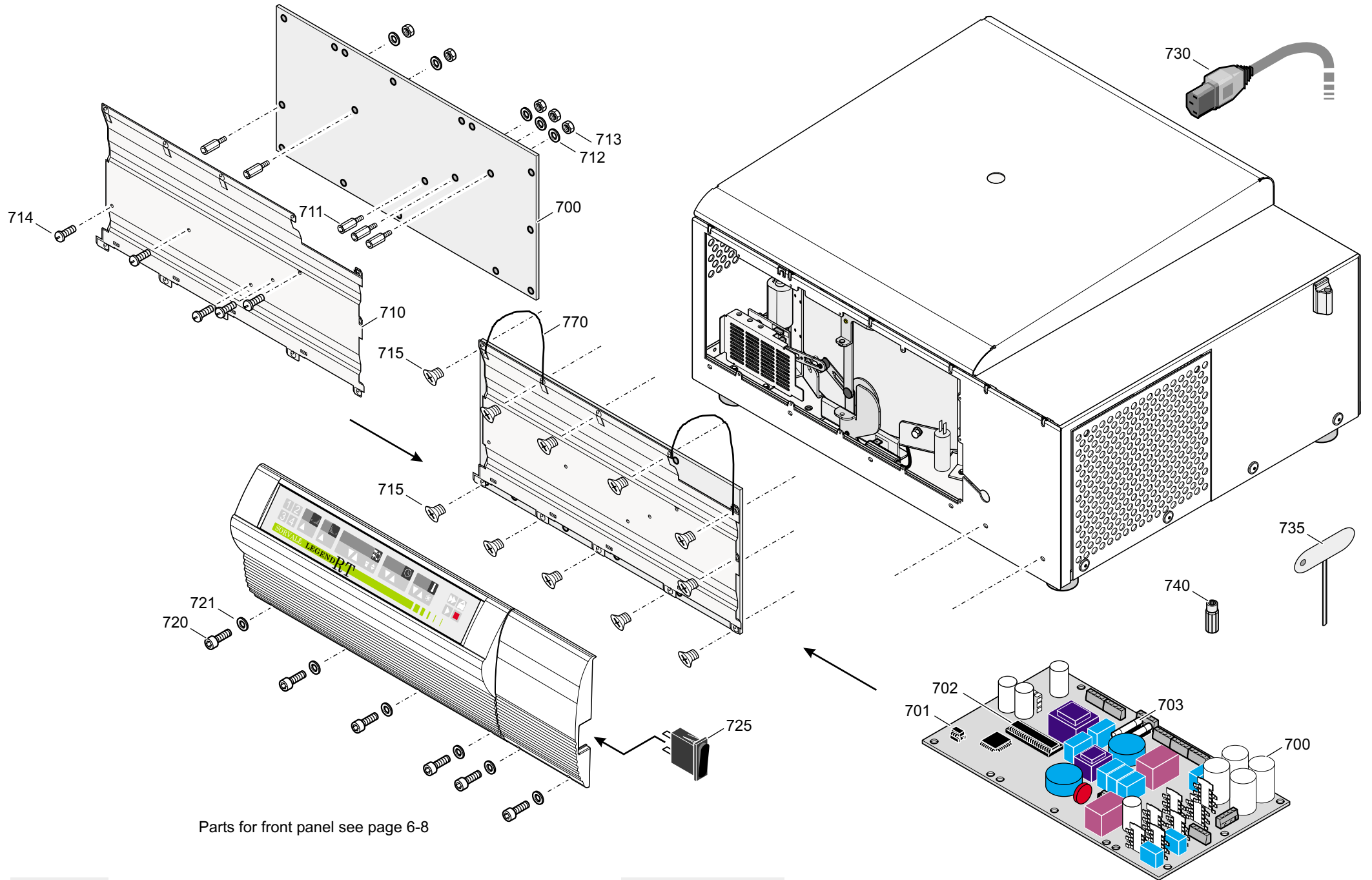


Parts for the lid see page 6-6

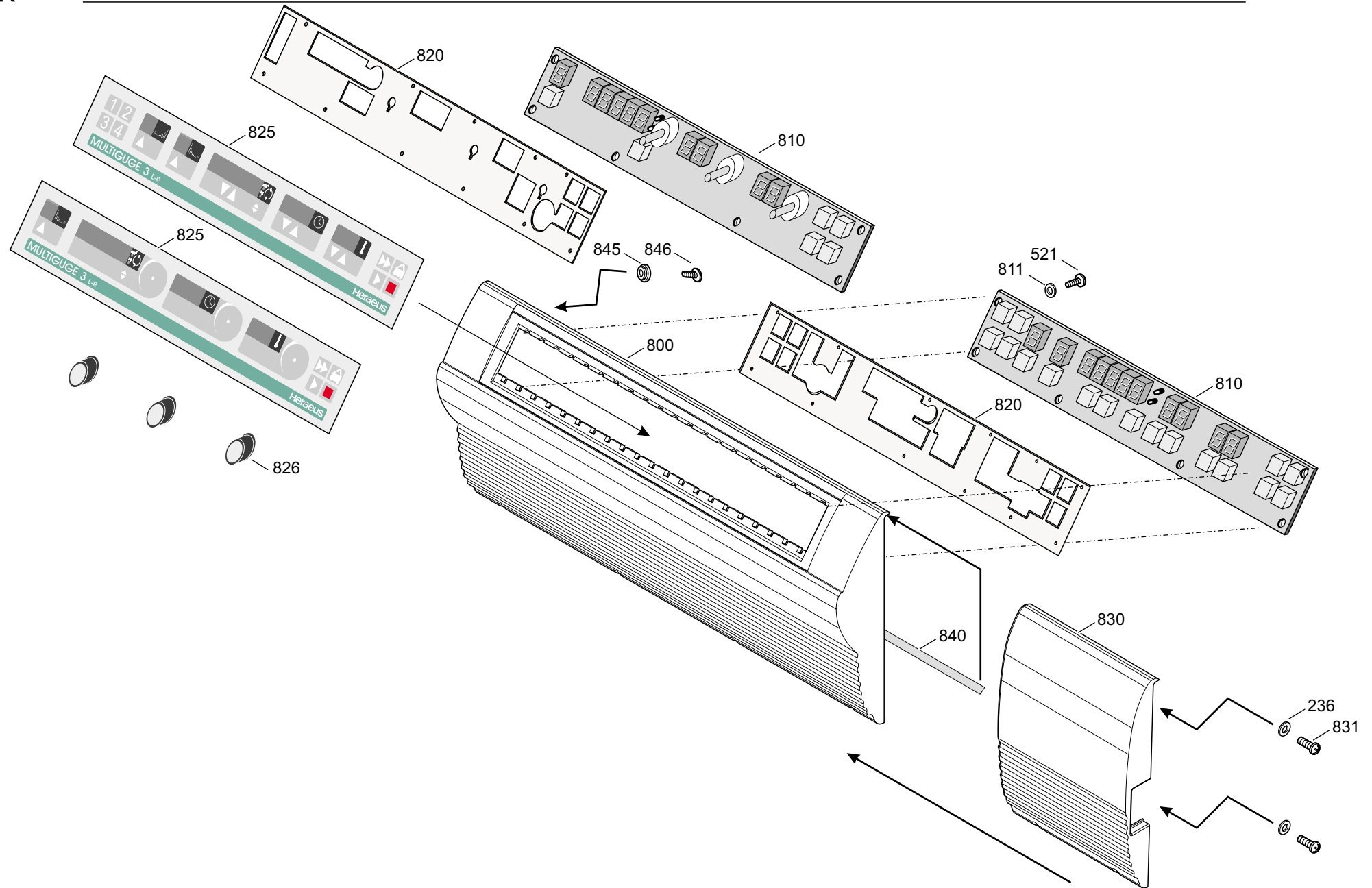




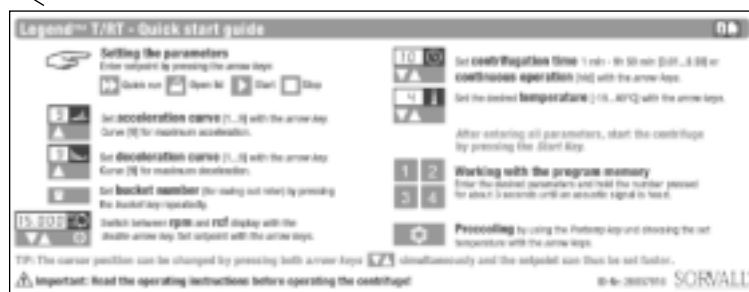




Parts for front panel see page 6-8



900



910

No.	Method	Rotor	Max. volume	Speed (rpm)	RCF (xg)	Time (min)	Auto-deceleration	Temp. (°C)
1								
2								
3								
4								

**Rotors and Buckets for Legend™ T/RT**

Rotor/Bucket	Depth, mm	Max. volume	Max. RCF
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700

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901



911

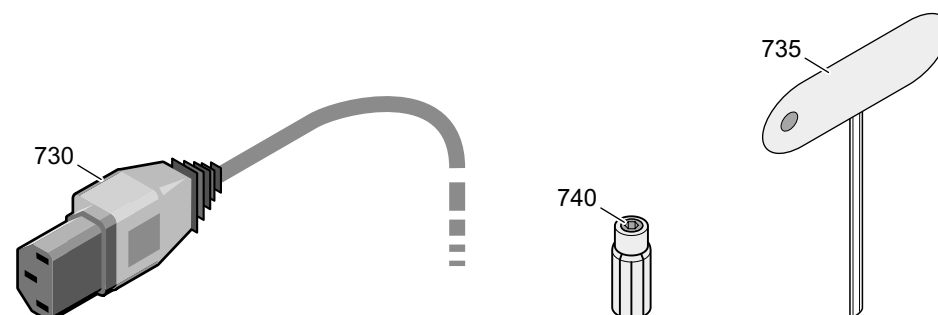
No.	Method	Rotor	Max. volume	Speed (rpm)	RCF (xg)	Time (min)	Auto-deceleration	Temp. (°C)
1								
2								
3								
4								

**Rotors and Buckets for Multifuge™ 3S/3S-R-3L-3L-R**

Rotor/Bucket	Depth, mm	Max. volume	Max. RCF
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700
Beckman SW 28	700x400	2.5 L	2700

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## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004374 . 01**

**MULTIFUGE 3L-R 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00100	70056704	Base
00101	20460089	SCREW M5X5
00102	20057535	Motorchassis
00103	20510292	SCREW
00104	20022874	ANTIVIBRATION MOUNT
00105	10104080	WASHER (SAND)
00106	20420167	NUT
00107	20057828	Noise reducer
00108	20057826	Weight
00109	20510356	Bolt
00110	20057827	Noise reducer
00111	70060304	Metallsheet
00112	20057941	Insulation
00120	20300084	FOOT
00121	20510247	Screw M8x12
00125	70057541	Chassis cover
00126	20480244	LOCK WASHER
00127	20460092	ALLEN SCREW M4 X 6
00130	70057534	Motorchassis
00135	20210390	MOTOR 125/45 3PH
00136	20056798	Insulation
00137	20150180	ROTOR RECOGNITION
00138	20510350	Bolt
00140	20150214	Speed and imbalance recognition
00141	20460097	Z-SCREW M3 X 8
00142	20480242	SECURING WASHER
00150	20180608	RECEPTACLE
00151	20440023	SCREW M3 X 8
00152	20460090	SCREW M4X12
00153	20420076	HEXAGONAL NUT M4
00160	20180138	CONNECTOR
00161	20480108	FAN WASHER A 4,3
00170	20170329	Ferroxcube ring
00171	20170330	FERROXCUBE
00200	20240607	Compressor SC 12 GX 115V/60Hz
00220	20056700	CONDENSOR
00221	20057488	Insulation
00222	20057487	Insulation

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004374 . 01**

**MULTIFUGE 3L-R 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00223	20056735	COVER
00224	20510354	Screw
00230	70056716	Bracket Fan-
00231	20510292	SCREW
00235	20210397	MOTOR FAN 115 V
00236	20480224	WASHER A 4,3
00237	20430207	SCREW M 4 X 10
00240	70056705	Evaporatorchassis
00250	70904335	Evaporator complete
00251	20430212	SCREW M 5 X 16
00255	20160733	RESISTOR 120 OHM
00256	20160734	RESISTOR 120 OHM
00257	20510352	Screw
00260	70904550	Resistor 100 Ohm F. Multi 3 R 120V
00265	20160737	CAPACITOR 4UF/400V
00270	20240577	FILTERDRYER
00271	20220598	Clip
00272	20440221	SCREW M 6 X 16
00300	20240592	HIGH PRESSURE CONTROLL SWITC
00305	20240608	Injection valve
00310	20056748	SEAL
00315	20290556	Insulation
00320	20290673	Insulation Armaflex
00325	20056761	MOTORCOVER
00326	20460103	SCREW M 3 X 12
00330	20055509	SUPPORT
00335	20140602	Sensor Temp. PT 100
00336	20250074	WASHER
00337	20470253	SCREW, PLASTIC
00340	70057552	Metall sheet
00400	20210391	MOTOR W GEAR
00405	20056715	Holder
00406	20460163	Screw
00410	20150186	PCB SENSOR
00415	70904339	COUPLING
00416	20510288	Set screw
00417	20440285	SCREW
00420	70056790	Sheet, left

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004374 . 01**

**MULTIFUGE 3L-R 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00425	70056789	Sheet, right
00430	20056737	Slideplate
00431	20460092	ALLEN SCREW M4 X 6
00432	20220586	INSULATION
00440	20056738	Roller
00441	20056739	Bolt 4
00442	20420107	NUT M 6 LEFT
00450	20056792	HOLDER LATCH PROTECTION
00451	20350242	Spring
00452	20056791	LATCH PROTECTION
00453	20460202	Screw Ejot
00454	20057932	Insulation
00460	20180677	SWITCH
00461	20460157	Bolt M 2,3
00465	70056718	Bracket, Latch-
00470	20180654	SWITCH
00471	20057257	Holder sheet
00475	70904336	LATCH ASSY
00476	20350241	Clip
00480	20056707	Bar
00481	20420070	NUT M 6
00500	70056726	Housing
00505	20057830	Grill
00510	20056650	HOLDER
00511	20510285	SCREW M5 X 12
00515	20310439	GAS LID STAY
00516	20490287	PIN
00520	20056766	SEAL
00521	20510294	SCREW M3 X 10
00525	20310442	Puller
00530	20057553	Holder, Tool-
00535	20056736	HINGE
00540	20056795	Panel, right
00600	70056741	Insert
00605	20057217	HOOK
00606	20480236	SECURING WASHER
00607	20420121	NUT M 10 X 1,25
00620	70904183	Cover, door

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004374 . 01**

**MULTIFUGE 3L-R 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00621	20420201	Nut
00630	20056731	Insulation, door
00631	20056762	Spacer
00635	20057563	Spacer
00640	20056734	Insulation small
00645	20056728	INSERT
00650	20057833	Seal
00660	20510360	Screw M5
00670	20056732	Window
00671	20056625	WINDOW, LOWER PART
00680	20510021	SCREW M 5 X 12
00681	20480200	WASHER
00682	20480167	FAN WASHER A 5,1
00685	20310504	Cover
00700	20150184	MAINBOARD 120V
00701	70904557	NV RAM
00702	70000528	PROCESSOR MAIN Legend 0528V07
00703	20230172	FUSE 15 A
00710	70060305	Cover
00711	20500200	Spacer
00712	20480300	Washer M4
00713	20420200	Nut M4
00714	20470263	Screw
00715	20440284	SCREW M 4 X 8
00720	20510293	Screw
00721	20480130	WASHER 4,3
00725	20180671	SWITCH W OVERLOADPROT. 16 A
00730	20190300	Cordset NEMA 5-15P 15A/125V 3x14A
00735	20360073	SCREW DRIVER
00740	20904430	COLLET CHUCK
00770	20310508	String w washer
00800	70060312	Frontpanel
00810	20150191	DISPLAY PCB
00811	20480124	WASHER
00820	20057551	Frontplate
00825	20057905	Overlay Multifuge 3L-R
00826	20310443	Knob f. Quickcontrolpanal Multifuge
00830	20056759	FRONTPANEL SIDE

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004374.01**

**MULTIFUGE 3L-R 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00831	20460164	Screw
00840	20290664	seal
00845	20057560	Spacer
00846	20460161	SCREW
00900	20057916	Operating instruction
00901	20057821	Short Instruction for Multifuge 3S engl.
00910	20057914	Instruction
00911	20057915	



## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004375 . 01**

**MULTIFUGE 3 S-R, 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00100	70056704	Base
00101	20460089	SCREW M5X5
00102	20057535	Motorchassis
00103	20510292	SCREW
00104	20022874	ANTIVIBRATION MOUNT
00105	10104080	WASHER (SAND)
00106	20420167	NUT
00107	20057828	Noise reducer
00108	20057826	Weight
00109	20510356	Bolt
00110	20057827	Noise reducer
00111	70060304	Metallsheet
00112	20057941	Insulation
00120	20300084	FOOT
00121	20510247	Screw M8x12
00125	70057541	Chassis cover
00126	20480244	LOCK WASHER
00127	20460092	ALLEN SCREW M4 X 6
00130	70057534	Motorchassis
00135	20210390	MOTOR 125/45 3PH
00136	20056798	Insulation
00137	20150180	ROTOR RECOGNITION
00138	20510350	Bolt
00140	20150214	Speed and imbalance recognition
00141	20460097	Z-SCREW M3 X 8
00142	20480242	SECURING WASHER
00150	20180608	RECEPTACLE
00151	20440023	SCREW M3 X 8
00152	20460090	SCREW M4X12
00153	20420076	HEXAGONAL NUT M4
00160	20180138	CONNECTOR
00161	20480108	FAN WASHER A 4,3
00170	20170329	Ferroxcube ring
00171	20170330	FERROXCUBE
00200	20240607	Compressor SC 12 GX 115V/60Hz
00220	20056700	CONDENSOR
00221	20057488	Insulation
00222	20057487	Insulation

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004375 . 01**

**MULTIFUGE 3 S-R, 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00223	20056735	COVER
00224	20510354	Screw
00230	70056716	Bracket Fan-
00231	20510292	SCREW
00235	20210397	MOTOR FAN 115 V
00236	20480224	WASHER A 4,3
00237	20430207	SCREW M 4 X 10
00240	70056705	Evaporatorchassis
00250	70904335	Evaporator complete
00251	20430212	SCREW M 5 X 16
00255	20160733	RESISTOR 120 OHM
00256	20160734	RESISTOR 120 OHM
00257	20510352	Screw
00260	70904550	Resistor 100 Ohm F. Multi 3 R 120V
00265	20160737	CAPACITOR 4UF/400V
00270	20240577	FILTERDRYER
00271	20220598	Clip
00272	20440221	SCREW M 6 X 16
00300	20240592	HIGH PRESSURE CONTROLL SWITC
00305	20240608	Injection valve
00310	20056748	SEAL
00315	20290556	Insulation
00320	20290673	Insulation Armaflex
00325	20056761	MOTORCOVER
00326	20460103	SCREW M 3 X 12
00330	20055509	SUPPORT
00335	20140602	Sensor Temp. PT 100
00336	20250074	WASHER
00337	20470253	SCREW, PLASTIC
00340	70057552	Metall sheet
00400	20210391	MOTOR W GEAR
00405	20056715	Holder
00406	20460163	Screw
00410	20150186	PCB SENSOR
00415	70904339	COUPLING
00416	20510288	Set screw
00417	20440285	SCREW
00420	70056790	Sheet, left

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004375 . 01**

**MULTIFUGE 3 S-R, 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00425	70056789	Sheet, right
00430	20056737	Slideplate
00431	20460092	ALLEN SCREW M4 X 6
00432	20220586	INSULATION
00440	20056738	Roller
00441	20056739	Bolt 4
00442	20420107	NUT M 6 LEFT
00450	20056792	HOLDER LATCH PROTECTION
00451	20350242	Spring
00452	20056791	LATCH PROTECTION
00453	20460202	Screw Ejot
00454	20057932	Insulation
00460	20180677	SWITCH
00461	20460157	Bolt M 2,3
00465	70056718	Bracket, Latch-
00470	20180654	SWITCH
00471	20057257	Holder sheet
00475	70904336	LATCH ASSY
00476	20350241	Clip
00480	20056707	Bar
00481	20420070	NUT M 6
00500	70056726	Housing
00505	20057830	Grill
00510	20056650	HOLDER
00511	20510285	SCREW M5 X 12
00515	20310439	GAS LID STAY
00516	20490287	PIN
00520	20056766	SEAL
00521	20510294	SCREW M3 X 10
00525	20310442	Puller
00530	20057553	Holder, Tool-
00535	20056736	HINGE
00540	20056795	Panel, right
00600	70056741	Insert
00605	20057217	HOOK
00606	20480236	SECURING WASHER
00607	20420121	NUT M 10 X 1,25
00620	70904183	Cover, door

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004375 . 01**

**MULTIFUGE 3 S-R, 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00621	20420201	Nut
00630	20056731	Insulation, door
00631	20056762	Spacer
00635	20057563	Spacer
00640	20056734	Insulation small
00645	20056728	INSERT
00650	20057833	Seal
00660	20510360	Screw M5
00670	20056732	Window
00671	20056625	WINDOW, LOWER PART
00680	20510021	SCREW M 5 X 12
00681	20480200	WASHER
00682	20480167	FAN WASHER A 5,1
00685	20310504	Cover
00700	20150184	MAINBOARD 120V
00701	70904552	NV-RAM PRV MULTI 3S-R / 120V 045
00702	70000528	PROCESSOR MAIN Legend 0528V07
00703	20230172	FUSE 15 A
00710	70060305	Cover
00711	20500200	Spacer
00712	20480300	Washer M4
00713	20420200	Nut M4
00714	20470263	Screw
00715	20440284	SCREW M 4 X 8
00720	20510293	Screw
00721	20480130	WASHER 4,3
00725	20180671	SWITCH W OVERLOADPROT. 16 A
00730	20190300	Cordset NEMA 5-15P 15A/125V 3x14A
00735	20360073	SCREW DRIVER
00740	20904430	COLLET CHUCK
00770	20310508	String w washer
00800	70060312	Frontpanel
00810	20150190	DISPLAY PCB
00811	20480124	WASHER
00820	20057550	FRONT
00825	20057904	Overlay
00830	20056759	FRONTPANEL SIDE
00831	20460164	Screw

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004375 . 01**

**MULTIFUGE 3 S-R, 120V/60HZ**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00840	20290664	seal
00845	20057560	Spacer
00846	20460161	SCREW
00900	20057916	Operating instruction
00901	20057821	Short Instruction for Multifuge 3S engl.
00910	20057914	Instruction
00911	20057915	

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004376 . 01**

**LEGEND RT 120V 60HZ QUICKCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00100	70056704	Base
00101	20460089	SCREW M5X5
00102	20057535	Motorchassis
00103	20510292	SCREW
00104	20022874	ANTIVIBRATION MOUNT
00105	10104080	WASHER (SAND)
00106	20420167	NUT
00107	20057828	Noise reducer
00108	20057826	Weight
00109	20510356	Bolt
00110	20057827	Noise reducer
00111	70060304	Metallsheet
00112	20057941	Insulation
00120	20300084	FOOT
00121	20510247	Screw M8x12
00125	70057541	Chassis cover
00126	20480244	LOCK WASHER
00127	20460092	ALLEN SCREW M4 X 6
00130	70057534	Motorchassis
00135	20210390	MOTOR 125/45 3PH
00136	20056798	Insulation
00137	20150180	ROTOR RECOGNITION
00138	20510350	Bolt
00140	20150214	Speed and imbalance recognition
00141	20460097	Z-SCREW M3 X 8
00142	20480242	SECURING WASHER
00150	20180608	RECEPTACLE
00151	20440023	SCREW M3 X 8
00152	20460090	SCREW M4X12
00153	20420076	HEXAGONAL NUT M4
00160	20180138	CONNECTOR
00161	20480108	FAN WASHER A 4,3
00170	20170329	Ferroxcube ring
00171	20170330	FERROXCUBE
00200	20240607	Compressor SC 12 GX 115V/60Hz
00220	20056700	CONDENSOR
00221	20057488	Insulation
00222	20057487	Insulation

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004376 . 01**

**LEGEND RT 120V 60HZ QUICKCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00223	20056735	COVER
00224	20510354	Screw
00230	70056716	Bracket Fan-
00231	20510292	SCREW
00235	20210397	MOTOR FAN 115 V
00236	20480224	WASHER A 4,3
00237	20430207	SCREW M 4 X 10
00240	70056705	Evaporatorchassis
00250	70904335	Evaporator complete
00251	20430212	SCREW M 5 X 16
00255	20160733	RESISTOR 120 OHM
00256	20160734	RESISTOR 120 OHM
00257	20510352	Screw
00260	70904550	Resistor 100 Ohm F. Multi 3 R 120V
00265	20160737	CAPACITOR 4UF/400V
00270	20240577	FILTERDRYER
00271	20220598	Clip
00272	20440221	SCREW M 6 X 16
00300	20240592	HIGH PRESSURE CONTROLL SWIT
00305	20240608	Injection valve
00310	20056748	SEAL
00315	20290556	Insulation
00320	20290673	Insulation Armaflex
00325	20056761	MOTORCOVER
00326	20460103	SCREW M 3 X 12
00330	20055509	SUPPORT
00335	20140602	Sensor Temp. PT 100
00336	20250074	WASHER
00337	20470253	SCREW, PLASTIC
00340	70057552	Metall sheet
00400	20210391	MOTOR W GEAR
00405	20056715	Holder
00406	20460163	Screw
00410	20150186	PCB SENSOR
00415	70904339	COUPLING
00416	20510288	Set screw
00417	20440285	SCREW
00420	70056790	Sheet, left

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004376 . 01**

**LEGEND RT 120V 60HZ QUICKCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00425	70056789	Sheet, right
00430	20056737	Slideplate
00431	20460092	ALLEN SCREW M4 X 6
00432	20220586	INSULATION
00440	20056738	Roller
00441	20056739	Bolt 4
00442	20420107	NUT M 6 LEFT
00450	20056792	HOLDER LATCH PROTECTION
00451	20350242	Spring
00452	20056791	LATCH PROTECTION
00453	20460202	Screw Ejot
00454	20057932	Insulation
00460	20180677	SWITCH
00461	20460157	Bolt M 2,3
00465	70056718	Bracket, Latch-
00470	20180654	SWITCH
00471	20057257	Holder sheet
00475	70904336	LATCH ASSY
00476	20350241	Clip
00480	20056707	Bar
00481	20420070	NUT M 6
00500	70056726	Housing
00505	20057830	Grill
00510	20056650	HOLDER
00511	20510285	SCREW M5 X 12
00515	20310439	GAS LID STAY
00516	20490287	PIN
00520	20056766	SEAL
00521	20510294	SCREW M3 X 10
00525	20310442	Puller
00530	20057553	Holder, Tool-
00535	20056736	HINGE
00540	20056795	Panel, right
00600	70056741	Insert
00605	20057217	HOOK
00606	20480236	SECURING WASHER
00607	20420121	NUT M 10 X 1,25
00620	70904183	Cover, door



## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004376 .01**

**LEGEND RT 120V 60HZ QUICKCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00621	20420201	Nut
00630	20056731	Insulation, door
00631	20056762	Spacer
00635	20057563	Spacer
00640	20056734	Insulation small
00645	20056728	INSERT
00650	20057833	Seal
00660	20510360	Screw M5
00670	20056732	Window
00671	20056625	WINDOW, LOWER PART
00680	20510021	SCREW M 5 X 12
00681	20480200	WASHER
00682	20480167	FAN WASHER A 5,1
00685	20310504	Cover
00700	20150184	MAINBOARD 120V
00701	70904557	NV RAM
00702	70000528	PROCESSOR MAIN Legend 0528V07
00703	20230172	FUSE 15 A
00710	70060305	Cover
00711	20500200	Spacer
00712	20480300	Washer M4
00713	20420200	Nut M4
00714	20470263	Screw
00715	20440284	SCREW M 4 X 8
00720	20510293	Screw
00721	20480130	WASHER 4,3
00725	20180671	SWITCH W OVERLOADPROT. 16 A
00730	20190300	Cordset NEMA 5-15P 15A/125V 3x14
00735	20360073	SCREW DRIVER
00740	20904430	COLLET CHUCK
00770	20310508	String w washer
00800	70060312	Frontpanel
00810	20150191	DISPLAY PCB
00811	20480124	WASHER
00820	20057551	Frontplate
00825	20057909	Overlay Legend RT (knob version)
00826	20310443	Knob f. Quickcontrolpanel Multifuge
00830	20056759	FRONTPANEL SIDE

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004376 . 01**

**LEGEND RT 120V 60HZ QUICKCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00831	20460164	Screw
00840	20290664	seal
00845	20057560	Spacer
00846	20460161	SCREW
00900	20057916	Operating instruction
00901	20057821	Short Instruction for Multifuge 3S engl.
00910	20057914	Instruction
00911	20057915	

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004377 . 01**

**LEGEND RT 120V 60HZ EASYCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00100	70056704	Base
00101	20460089	SCREW M5X5
00102	20057535	Motorchassis
00103	20510292	SCREW
00104	20022874	ANTIVIBRATION MOUNT
00105	10104080	WASHER (SAND)
00106	20420167	NUT
00107	20057828	Noise reducer
00108	20057826	Weight
00109	20510356	Bolt
00110	20057827	Noise reducer
00111	70060304	Metallsheet
00112	20057941	Insulation
00120	20300084	FOOT
00121	20510247	Screw M8x12
00125	70057541	Chassis cover
00126	20480244	LOCK WASHER
00127	20460092	ALLEN SCREW M4 X 6
00130	70057534	Motorchassis
00135	20210390	MOTOR 125/45 3PH
00136	20056798	Insulation
00137	20150180	ROTOR RECOGNITION
00138	20510350	Bolt
00140	20150214	Speed and imbalance recognition
00141	20460097	Z-SCREW M3 X 8
00142	20480242	SECURING WASHER
00150	20180608	RECEPTACLE
00151	20440023	SCREW M3 X 8
00152	20460090	SCREW M4X12
00153	20420076	HEXAGONAL NUT M4
00160	20180138	CONNECTOR
00161	20480108	FAN WASHER A 4,3
00170	20170329	Ferroxcube ring
00171	20170330	FERROXCUBE
00200	20240607	Compressor SC 12 GX 115V/60Hz
00220	20056700	CONDENSOR
00221	20057488	Insulation
00222	20057487	Insulation

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004377 . 01**

**LEGEND RT 120V 60HZ EASYCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00223	20056735	COVER
00224	20510354	Screw
00230	70056716	Bracket Fan-
00231	20510292	SCREW
00235	20210397	MOTOR FAN 115 V
00236	20480224	WASHER A 4,3
00237	20430207	SCREW M 4 X 10
00240	70056705	Evaporatorchassis
00250	70904335	Evaporator complete
00251	20430212	SCREW M 5 X 16
00255	20160733	RESISTOR 120 OHM
00256	20160734	RESISTOR 120 OHM
00257	20510352	Screw
00260	70904550	Resistor 100 Ohm F. Multi 3 R 120V
00265	20160737	CAPACITOR 4UF/400V
00270	20240577	FILTERDRYER
00271	20220598	Clip
00272	20440221	SCREW M 6 X 16
00300	20240592	HIGH PRESSURE CONTROLL SWITC
00305	20240608	Injection valve
00310	20056748	SEAL
00315	20290556	Insulation
00320	20290673	Insulation Armaflex
00325	20056761	MOTORCOVER
00330	20055509	SUPPORT
00335	20140602	Sensor Temp. PT 100
00336	20250074	WASHER
00337	20470253	SCREW, PLASTIC
00340	70057552	Metall sheet
00400	20210391	MOTOR W GEAR
00405	20056715	Holder
00406	20460163	Screw
00410	20150186	PCB SENSOR
00415	70904339	COUPLING
00416	20510288	Set screw
00417	20440285	SCREW
00420	70056790	Sheet, left
00425	70056789	Sheet, right

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004377 . 01**

**LEGEND RT 120V 60HZ EASYCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00430	20056737	Slideplate
00431	20460092	ALLEN SCREW M4 X 6
00432	20220586	INSULATION
00440	20056738	Roller
00441	20056739	Bolt 4
00442	20420107	NUT M 6 LEFT
00450	20056792	HOLDER LATCH PROTECTION
00451	20350242	Spring
00452	20056791	LATCH PROTECTION
00453	20460202	Screw Ejot
00454	20057932	Insulation
00460	20180677	SWITCH
00461	20460157	Bolt M 2,3
00465	70056718	Bracket, Latch-
00470	20180654	SWITCH
00471	20057257	Holder sheet
00475	70904336	LATCH ASSY
00476	20350241	Clip
00480	20056707	Bar
00481	20420070	NUT M 6
00500	70056726	Housing
00505	20057830	Grill
00510	20056650	HOLDER
00511	20510285	SCREW M5 X 12
00515	20310439	GAS LID STAY
00516	20490287	PIN
00520	20056766	SEAL
00521	20510294	SCREW M3 X 10
00525	20310442	Puller
00530	20057553	Holder, Tool-
00535	20056736	HINGE
00540	20056795	Panel, right
00600	70056741	Insert
00605	20057217	HOOK
00606	20480236	SECURING WASHER
00607	20420121	NUT M 10 X 1,25
00620	70904183	Cover, door
00621	20420201	Nut

## Spare-Part-List

## Kendro Laboratory Products

Plant Osterode

**75004377 . 01**

**LEGEND RT 120V 60HZ EASYCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00630	20056731	Insulation, door
00631	20056762	Spacer
00635	20057563	Spacer
00640	20056734	Insulation small
00645	20056728	INSERT
00650	20057833	Seal
00660	20510360	Screw M5
00670	20056732	Window
00671	20056625	WINDOW, LOWER PART
00680	20510021	SCREW M 5 X 12
00681	20480200	WASHER
00682	20480167	FAN WASHER A 5,1
00685	20310504	Cover
00700	20150184	MAINBOARD 120V
00701	70904552	NV-RAM PRV MULTI 3S-R / 120V 045
00702	70000528	PROCESSOR MAIN Legend 0528V07
00703	20230172	FUSE 15 A
00710	70060305	Cover
00711	20500200	Spacer
00712	20480300	Washer M4
00713	20420200	Nut M4
00714	20470263	Screw
00715	20440284	SCREW M 4 X 8
00720	20510293	Screw
00721	20480130	WASHER 4,3
00725	20180671	SWITCH W OVERLOADPROT. 16 A
00730	20190300	Cordset NEMA 5-15P 15A/125V 3x14A
00735	20360073	SCREW DRIVER
00740	20904430	COLLET CHUCK
00770	20310508	String w washer
00800	70060312	Frontpanel
00810	20150190	DISPLAY PCB
00811	20480124	WASHER
00820	20057550	FRONT
00825	20057908	Overlay Legend RT
00830	20056759	FRONTPANEL SIDE
00831	20460164	Screw
00840	20290664	seal

## Spare-Part-List

Kendro Laboratory Products

Plant Osterode

**75004377 . 01**

**LEGEND RT 120V 60HZ EASYCONTROL**

from Serial-No. 40031227

to Serial-No.

Index	Partno.	Text
00845	20057560	Spacer
00846	20460161	SCREW
00900	20057916	Operating instruction
00901	20057821	Short Instruction for Multifuge 3S engl.
00910	20057914	Instruction
00911	20057915	



**Preventive Maintenance Checklist Complete**  
Vorbeugende Wartungsliste, vollstdg



**Repair and Calibration Recertification**  
Reparatur und Wiederholungskalibrierung

**Account Name:**

**Account Address:**

**Instrument Model:**

**Serial Number:**

**Report Number:**

**Date:**

### Performance Certification / Durchführung

#### SPEED / DREHZAHL

Standard Test			Rotor Used:			
Set Speed (rpm)	Tolerance (whichever is greater)	Displayed Speed (rpm)	Measured Speed (rpm)	Meets Spec. (y/n)	Remarks	Passed (Initials)
4150/4600	+/-1% or 50 rpm					
15000	+/-1% or 50 rpm					
Custom Test			Rotor Used:			
	+/-1% or 50 rpm					
	+/-1% or 50 rpm					

#### TEMPERATURE / TEMPERATUR

Standard Test			Rotor Used:			
Calibration Temp. (°C)	Tolerance (°C)	Displayed Temp. (°C)	Measured Temp. (°C)	Meets Spec. (y/n)	Remarks	Passed (Initials)
+4	+/- 2					
+15	+/- 3					
Custom Test			Rotor Used:			
	+/- 2					
	+/- 2					
	+/- 2					

#### TIME / ZEIT

TIME / ZEIT					
Standard Test		Rotor Used:			
Timer Set (min.)	Tolerance (sec.)	Measured Time (m/s)	Meets Spec. (y/n)	Remarks	Passed (Initials)
10	+/- 30				
Custom Test		Rotor Used:			
	+/- 30				
	+/- 30				
	+/- 30				

#### TEST EQUIPMENT / PRÜFMITTEL

Type	Model	Serial Number	Date of Next Calibration
Stopwatch			
Temperature Meter			
Photo Tachometer			
Safety Tester			

#### SAFETY TEST / SICHERHEITSTEST

Insulations resistance	Earth Conductor Resistance	Accessible Current
>10 Megaohm	<0.2 Ohm	<3500µA

**Revised 29/09/00**

Certified By: \_\_\_\_\_ Reviewed By: \_\_\_\_\_ Expiration Date \_\_\_\_\_

Signature

Date

Customer Signature

Date



# Heraeus Centrifuges

## PREVENTIVE MAINTENANCE CHECKLIST

<b>Multifuge/Legend</b> <b>Type</b> <b>S/N</b>
--

### Rotor Inspection

- o Check for corrosion and wear
- o Inspect rotor lid locking screw
- o Inspect rotor magnets (rotor I.D.)  
Serial numbers:  
75006445.....  
75006435.....  
75006444.....  
75003332.....  
75003046.....  
75003334.....

- o instrument top speed \_\_\_\_\_rpm
- o Deceleration time \_\_\_\_\_seconds
- o Time (10 minute set) \_\_\_\_\_actual min:sec
- o Temperature (4° set) \_\_\_\_\_actual (°C)

### Imbalance

- o Centrifuge stable and level
- o Centrifuge shuts off w/proper weight

### Safety test

- o Accessible leakage current <3500µA
- o Insulation resistance >10 Megaohm
- o Earth Conductor Resistance <0.2 Ohm

### Preliminary Checks

- o Clean inst. & condenser coils
- o Rotor chamber (defrost)
- o Inst. environment  
(level & clearance)

### Pre-run Checks

- o Ground continuity
- o Line voltage \_\_\_\_\_V AC
- o Display segments on power-up
- o Door interlock and latch
- o Drive stop & Door unlatch (50 rpm)
- o Fan operation (condenser & drive)

### Mechanical

- o Motor bearings
- o Microprocessor Initialization (if required)
- o Refrigerant leaks (if required)
- o Compressor current draw

### Performance Checks

- o Acceleration time \_\_\_\_\_seconds

# Kendro service Information

**Comments:**

S.R. Signature \_\_\_\_\_  
Date of Service \_\_\_\_\_